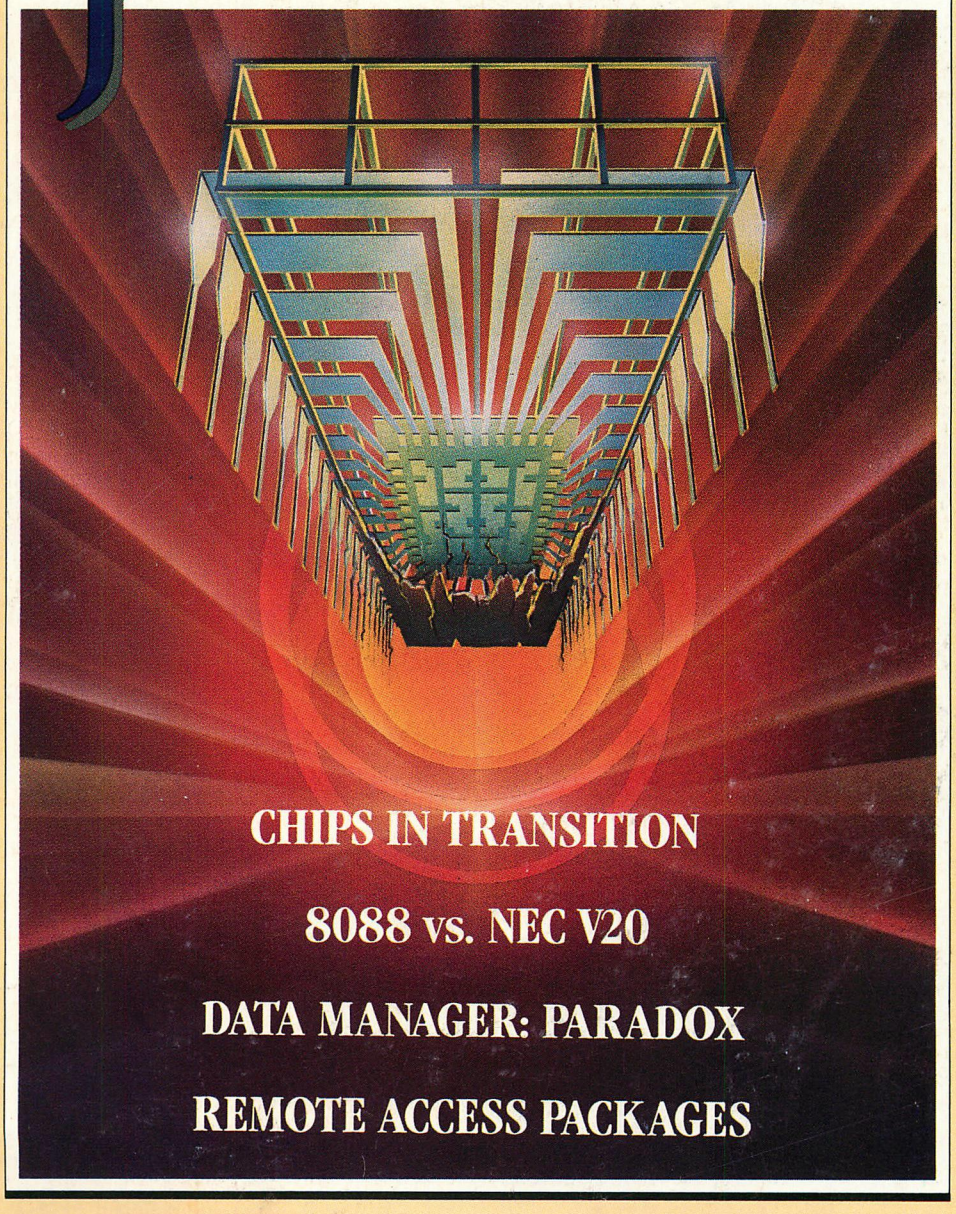
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FOR IBM PERSONAL COMPUTER USERS

PC TECH JOURNAL



CHIPS IN TRANSITION

8088 vs. NEC V20

DATA MANAGER: PARADOX

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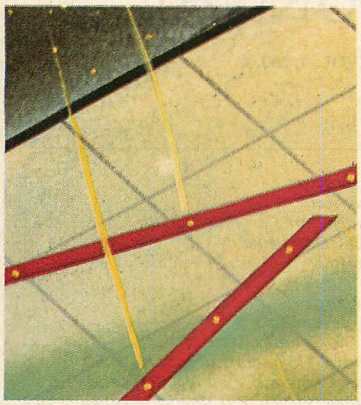
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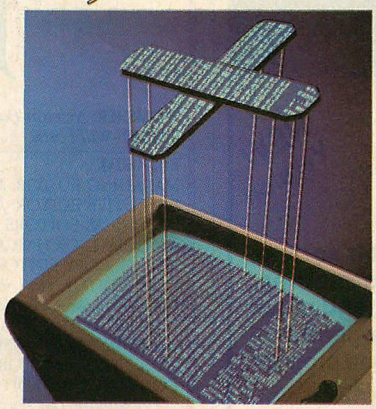
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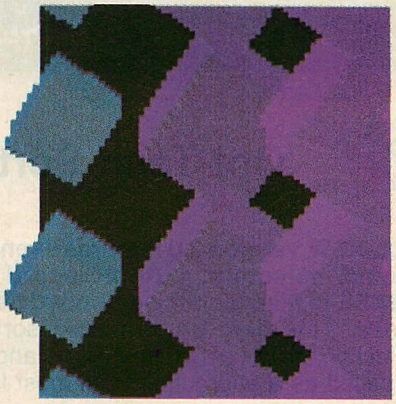
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BPA

Periscope Delivers Professional Debugging Power

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Periscope is "Always there with just a push of the button". Whenever something unexpected happens, just press the break-out switch and Presto! Periscope's debugging power is at your command. You can check out the problem right away.

Periscope uses names—symbols—from your program so you don't have to remember addresses. It displays source code and line numbers from high-level languages, too. You save hours of time because you access what you need with familiar names!

Periscope's unique breakpoints force bugs out from where they hide. With over 75 breakpoint options, including the ability to write your own breakpoint tests, you'll find those elusive bugs fast!

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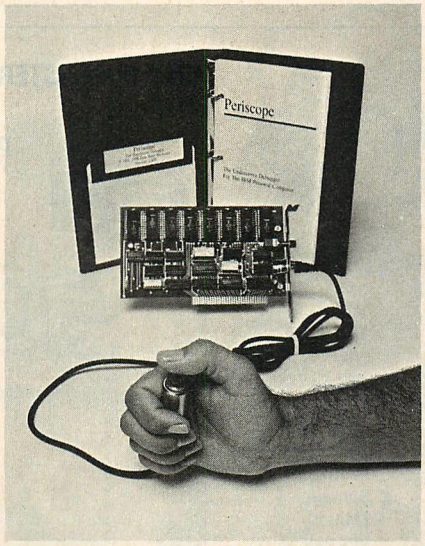
"I can't live without it!! BRIEF, a text editor my company wrote, would not be as stable as it is today without Periscope." —David Nanian

With Periscope's broad range of capabilities, you can thoroughly debug your software, giving it the reliability it needs.

One user says that Periscope is a "superbly engineered product" with "virtually every feature possible!"

Here's a sampling of the features:

- See procedure and variable names PLUS source code and line numbers from high-level languages!
- Symbolic In-line Assembler
- 75+ Breakpoint Options—including breakpoints on reads/writes to memory and I/O ports!
- Traceback—see up to 2,016 previous instructions!
- Optional Windows—change them while debugging!
- Optional On-line Help
- Single/Dual-Monitor Support — great for debugging screen-intensive programs!
- View Text Files
- User Exits—customize Periscope with your own programs!
- 8087/80287 Status
- Display memory in most any format



The break-out switch gives you what one user calls "spontaneity of debugging". Press it anytime to stop the executing program and see what's going on. The switch is so handy you'll want to use it to learn more about your PC!

DEBUG PROGRAMS OTHER DEBUGGERS CAN'T

"Periscope has changed my programming life and is truly unique among PC debuggers . . . [it] enables me to debug keyboard routines, device drivers . . . without errors. Periscope is rock solid." —Doug Roberts

Debug memory-resident and non-DOS programs, device-drivers, keyboard handlers, and interrupt-driven programs. Recover when your system hangs or your keyboard locks up. Safely check out what's going on in your system anytime. Debug when DOS is not working, debug DOS.

If your bugs can be found with a software debugger, Periscope can track them down! (We've heard that a competitor uses Periscope to debug his debugger.)

GET THE BEST VALUE!

"[Periscope is] the best value in development tools currently on the market." —Jeff Garbers

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HOW TO DECIDE BETWEEN PERISCOPE I & PERISCOPE II

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The key difference between Periscope I and Periscope II is the 'Submarine' board included with the Periscope I package. When you install Periscope I, crucial debugger software loads into the board's memory, which is then write-protected. You don't have to worry about a runaway program destroying it! Periscope II loads into low memory.

BREAK-OUT SWITCH

The break-out switch included with either model of Periscope enables you to debug anytime, even if your system is hung. The Periscope II switch taps into an already-in-use slot, so you don't need a spare slot to install it. The Periscope I switch plugs into the back of the 'Submarine' board, which requires a slot.

WHICH MODEL DO YOU NEED?

If your program writes to memory below itself, you need Periscope I's protected memory to make sure crucial debugger software isn't overwritten. Other than the protected memory, Periscope I and Periscope II are functionally the same debugger!

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Philippe Kahn, President, Borland

HOW BORLAND DOES SO MUCH, SO WELL, SO FAST

We asked Borland International president Philippe Kahn to share his secrets for rapidly taking a good idea and turning it into rock-solid reality. How does the Borland team do so much, so well, so fast?

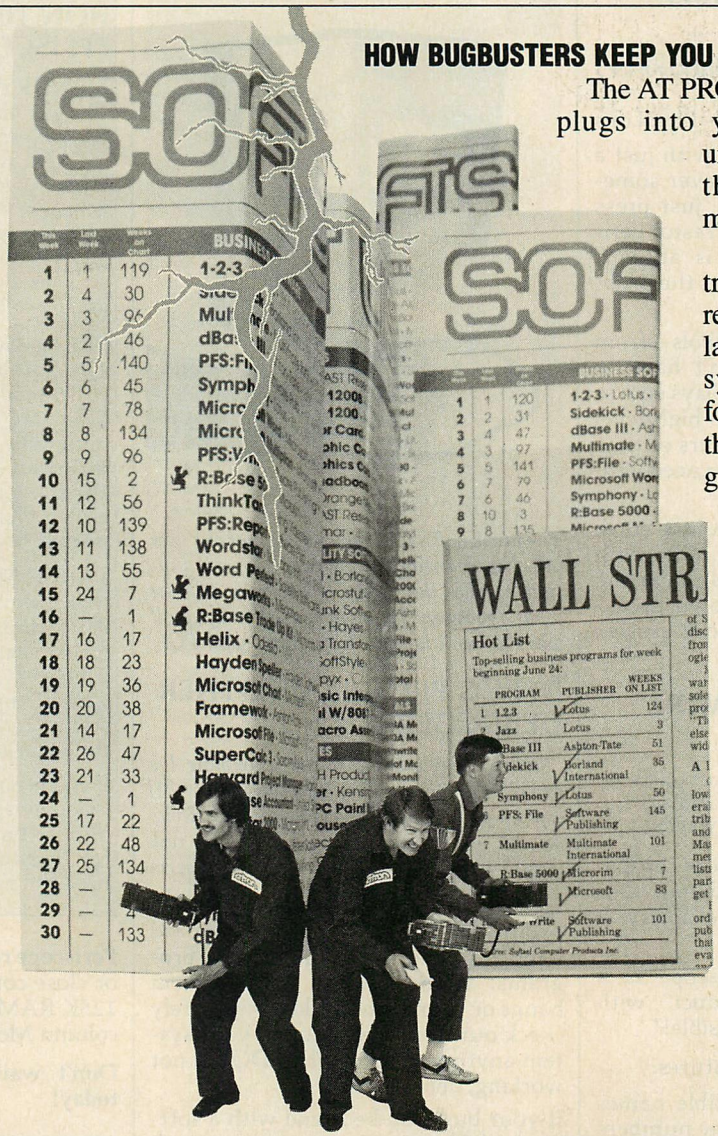
He begins, "I remember when Atron used the June 24, 1985 *Wall Street Journal* chart of top-selling software in an ad." [Note: At that time, seven of the top ten software packages were created by Atron customers; it's now now nine out of ten.] "SideKick was number four, and I let Atron quote me in saying that there wouldn't have been a SideKick without Atron's hardware-assisted debuggers.

"You might say lightning has literally struck again. Turbo Lightning made number four on *SoftSel's Hotlist* within weeks of its introduction! And again, I say we couldn't have done it without Atron debugging technology.

"Cleverly written code is, by definition tight, recursive, and terribly complex," he continues. "Without the ability to externally track the execution of this code, competent debugging becomes very nearly impossible."

Concludes Philippe, "And after Turbo Lightning was solid and reliable, Atron tuning software turned our Probes into performance analyzers. How do you think we *greased* our lightning?"

Philippe, along with a couple million or so of your satisfied customers, we say congratulations on yet another best-selling product. We can't wait to see what awesomely useful technology will come shooting out of Borland International next.



HOW BUGBUSTERS KEEP YOU FROM GETTING SLIMED

The AT PROBE is a circuit board that plugs into your PC/AT. It has an umbilical which plugs into the 80287 socket and monitors all 80286 activity.

Since AT PROBE can trace program execution in real time, and display the last 2048 memory cycles in symbolic or source-code form, you can easily answer the questions: "How did I get here?" and "What *are* those silly interrupts doing?"

It can solve *spooky* debugging problems. Like finding where your program overwrites memory or I/O - impossible with software debuggers.

You can even do source-level debugging in your favorite language, like C, Pascal or assembler. And after your application is debugged, the AT PROBE's performance measurement software can isolate performance bottlenecks.

Finally, the AT PROBE has its own 1-MByte of memory. Hidden and write-protected. How else could you develop that really large program, where the symbol table would otherwise take up most of memory.

LOOK AT IT THIS WAY.

History shows that non-Atron customers don't stand a very good chance of making the Top Ten list. Lightning *really does* have a way of striking twice!

The PC PROBE™ is $1595 and the AT PROBE is $2495. So call Atron today. You can be busting some really scarey bugs tomorrow. And maybe, just like Borland, you can also bust some records.

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AT vs RT

Is IBM really addressing the technical marketplace?

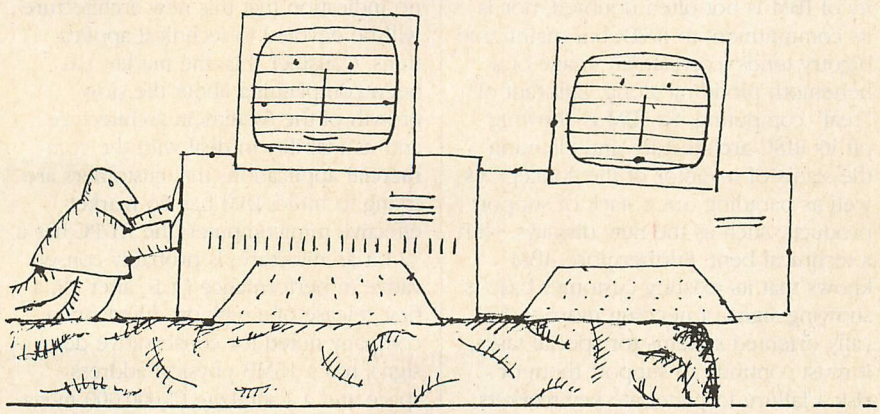


ILLUSTRATION • MACIEK ALBRECHT

A year and a half ago, IBM made a number of coordinated product announcements designed to demonstrate its commitment to the technical marketplace. *PC Tech Journal's* coverage of these products has centered on the graphics capabilities brought to PCs by the Enhanced Graphics Adapter and Display, the Professional Graphics Controller and Display, and a variety of software products to support this hardware, including the Graphics Development Toolkit, Graphical Kernel System, Plotting System, and Graphics Terminal Emulator. We have also reviewed the IBM Data Acquisition and Control Adapter and its software support.

That set of announcments in September 1984 also included some items that we have not examined closely, such as E/S³ (Engineering/Scientific Support System), an environment for the 4300 processor family that supports a technical department with interactive graphics tools, analysis and simulation, personal computing (with the 4300-based languages FORTRAN-77, APL, BASIC, and Pascal), office functions (via PROFS), and text processing. E/S³ also provides support for workstations (mostly PC-family products), attachment for non-IBM devices, Unibus and RS-232 interfaces, and custom-written device driver software for special user requirements.

IBM even announced the 7171, a refrigerator-sized device called the ASCII Device Attachment Control Unit, which has a $12,000 price tag for a 16-port model. What is impossible to deduce from the name, however, is the ability of the device to provide mainframe connectivity for different types of ASCII terminals and PCs, extensive 3270 emulation, and printer attachment and support, and to handle local editing.

Except for the EGA, these products failed to induce excitement in the technical segment of the marketplace. But they were signficant for another reason. At the press announcement, IBM was surprisingly candid in describing its perception of the size of the market (bigger than necessary to interest IBM) and the nature of the company's intent to carve a share for itself (decidedly aggressive). Because these announcements came just one month after the announcement of the PC/AT, IBM seemed to be pointing to the AT as the foundation for workstation products.

The last 18 months have demonstrated that the AT is not quite up to the task, and IBM has provided no extensions or upgrades to improve the situation. Worse, the AT has been an embarassment because of its early hard-disk problems and the rapid penetration of other manufacturers' AT-clones, all of which offer a bigger bang for the buck in performance or features. IBM's share of the market for desktops based on the Intel 80286 processor is significantly less than its share of the PC market, to the delight of the competition.

For the technical market, the AT lacks performance and capacity. The processor runs more slowly than all the other machines (6 MHz versus 8) and the hard-disk subsystem does not perform as fast as it could. Operating software to allow execution of programs in protected mode (and tools to allow their creation) does not exist, thus limiting technical, memory-intensive applications. On the graphics side, the EGA delivers less resolution than the workstation market seems to demand (640 horizontal by 350 vertical compared to the RT's 720-by-512 or 1,024-by-768) and far less performance because of its 8-bit data path and somewhat conservative electrical design. The PGC has only slightly better resolution and the same 8-bit data path; although it has an on-board processor with graphics primitives, it operates relatively slowly.

A faster 286, faster disk, better O/S, and 16-bit EGA would turn the AT into a more reasonable workstation that could be enhanced with yet higher resolution displays. Will we get it? That is anybody's guess.

A DIFFERENT TACK

What IBM conveyed more than anything else in September 1984 was its seriousness about the technical market. The recently announced IBM RT Personal Computer (see Tech Releases, this issue, p. 34) is obviously a more direct assault, but it is surprisingly weak.

The primary reason for this statement is price. A configured desktop model of the RT/PC is about $2,500 more than its Sun Microsystems counterpart; Sun, Apollo, DEC, and others are rumored to have even more cost-effective models in the works. A com-

pany such as Sun has another strong advantage: it is smaller and more agile, able to respond quickly to the desires of the market. Most industry analysts predicted that IBM could snare a 50-percent share of the workstation market with RT-based systems, but other, more careful observers saw the price spread, a few weaknesses in the design, and several areas of less-than-expected performance (graphics, floating point, and memory). So, what is going on?

First, IBM wants (and needs) to display some technical prowess to the technical market. The technical capability of IBM is not often doubted, nor is its committment to R&D, but mainframe bigotry tends to create an image of a behemoth plodding along, ignorant of "real" computing. So IBM is showing off its RISC architecture and claiming the status of inventor of the concept, as well as parading out a stack of support products, such as the new displays, with a technical bent. Furthermore, IBM knows that its existing customer base is showing signs of needing more technically oriented systems for special tasks; it must continue to support them or risk a failure to penetrate key markets.

This last point seems the crux of the IBM strategy at the moment. Once again IBM provides a "blue" solution to customers who are comforted by that. These customers will not be put off by the RT's weaknesses, especially because they have the inside track to an RT option: a discount. Depending on individual circumstances, a mainframe customer may be able to lower the effective price of the RT to competitive levels by, for example, bundling an RT purchase with a new mainframe.

There may be more to the RT than meets the eye, however. IBM has given no indication that this new architecture will be devoted to technical applications. Consider this: the market has been complaining about the slow growth of the System/36 architecture and its inability to deal with the commercial applications that customers are trying to build; IBM has no market-effective minicomputer; the RT/PC has a 32-bit architecture, is probably conservative in performance (it is, after all, a first release of a new product from a company noted for conservative design), has a 16MB physical address space and a 1 terabyte (1,000,000 megabytes) virtual space and boasts a very interesting Virtual Resource Manager (VRM) that is similar to the mainframe O/S VM—that alone speaks for greater potential for the machine.

About the only general objection to the RT is its I/O channel. The internal 32-bit path is converted to the 8- and 16-bit paths of the AT bus so that existing PC-family add-ins can be used. Judging from IBM-supplied documents, however, this I/O channel logic appears to be isolated and could be easily modified or replaced at a later time to achieve higher performance, higher bandwidth, or both.

Could IBM announce a minicomputer we would take seriously? Probably not, because of its lack of success in that market for the past 15 years. Could IBM announce a new desktop different from the AT, that we would like? Probably not, because we would condemn them for failing to toe the compatibility line. But what about something in between, something that is both and neither, something that can be camouflaged? Would we be willing to take that seriously?

Sooner or later, we just might.

OUR EYE ON NEW PRODUCTS

Every month, *PC Tech Journal* is a source of information about new products. This information comes in a variety of forms: advertising; Product of the Month, which focuses on one new product that holds particular interest; Tech Releases, our new products section; and Tech Book, our classified advertising section.

Nonetheless, we found ourselves unable to deliver reviews of many products that we felt merited our readers' consideration and attention. Our policy of in-depth examinations sometimes puts us in the awkward position of wanting to review a product but finding it somehow "too small." At the same time, we were very interested in some of these products, using them around the office or telling friends and associates about them.

We are also regularly confronted with the problem of updates to products we have previously (especially recently) reviewed. An axiom of computer publishing is that the appearance of a review of ten products will be followed, sometimes within milliseconds, by updates to at least two of the products. We cannot immediately redo a major article, but the vendor should not have to wait a year or so for our next look at the product.

To deal with these problems, Product Watch, a regular department of *PC Tech Journal*, was introduced in last month's issue. It features brief analyses of products that we otherwise might be unable to cover. It also contains updates to previous articles, including information regarding a new release of a product that addresses weaknesses we observed, a quick look at brand new entries in a category recently covered, or just some missed facts about a product that might change our opinion of it.

Count on us to do our best to get maximum information in the limited space allotted to each Product Watch entry. Do not be deceived by the brevity: as with all *PC Tech Journal* reviews, the product will have undergone a complete examination by the author and verification at the editorial office, even if it is only an update.

I doubt that we can cover all the products you might like to see us review. But given what we have seen so far, we are very pleased with Product Watch. We hope you will be too.

—WF

ARCHIVES AWAY

We have made an important addition to the library of programs that are available to readers in the public domain section of PCTECHline. System Enhancement Associates has allowed us to provide ARC.EXE, a program to manage archive libraries.

An archive library, identified by the extension .ARC, holds a group of related files in a compressed format. Because the archive libraries are, in effect, smaller than the sum of their parts, they provide an effective way to reduce connect time (and your phone bill) to PCTECHline.

Some files have been archived by topic. For example, all of the files for "Improving Turbo's I/O" (Cole Brecheen, September 1985, p. 104) are gathered into one .ARC file. Perhaps more appropriately, we began to archive by month with the January 1986 issue, placing all listings from the magazine in a single .ARC file. A directory listing of all PCTECHline sections is kept in PCTJ_DIR.ARC in the public domain section.

Instructions for using ARC.EXE can be found in the ARC.DOC file, also in the public domain section.

—DB

Microsoft languages speak for themselves.



Loud and clear.

Microsoft has been the language leader from day one. From the world's favorite BASIC to the systems languages software developers prefer. No one else has put so much programming power on so many micros.

Microsoft offers a complete set of languages. Whether you favor the elegance of C, or the power of assembly language. From data munching in COBOL to number crunching in FORTRAN, we've got the power you need.

The advantages of leadership.

Microsoft languages have developed quite a following. They're backed by the largest collection of support libraries you've ever seen. Packages for advanced mathematics and data management. From graphics support to context-sensitive editors. All available today. So you can spend your time solving real problems, not reinventing the wheel.

Microsoft's languages—like C, FORTRAN, Pascal and Macro Assembler—have become the favorites of commercial software developers. It's not surprising. Interlanguage calling allows libraries written in one language to be used with others. Which means your existing routines can be an investment in future projects, not lost time and effort.

Our interactive debuggers are another Microsoft edge. Now you can debug the object code using the source language. Easier debugging lets you spend more time creating.

Pipelines to the future.

Microsoft wrote the book when it comes to operating systems. Nobody knows MS-DOS® or XENIX® better. And our languages show it. We put the latest advances within your grasp. From networking and pipes to multi-tasking, Microsoft languages have the edge you need.

Complete support.

Only Microsoft offers language support this comprehensive. Our clear, thorough documentation, and regular product enhancements are setting new standards in the industry. Add our technical "hotline" and our highly-trained support staff, and you'll reach the same conclusion the industry has: Microsoft languages always lead from strength.



Microsoft C

First with the pros.

"Microsoft C is the cornerstone of all our future development projects. Not only is the code more efficient, we can really exploit the PC's architecture with Microsoft C's NEAR and FAR pointer types."
Ray Ozzie, President of IRIS Associates and key Symphony developer.

"The code optimization is impressive—especially the register declarations."
Jim Bean, Peachtree Software.

When you need code that's small and fast, Microsoft® C is the language.

Our optimizing compiler lets you squeeze the maximum out of your machine with minimum effort. Tighter code runs faster. And virtually every program will run faster with Microsoft's C Compiler than with any other MS-DOS compiler.

Our advanced memory models give you unmatched flexibility. No arbitrary limits on code and data. Use large or small memory models as the application demands. Exclusive features like our NEAR and FAR pointers let you combine different models without sacrificing performance.

Our extensive math libraries are another plus. The floating point package supports 8087 operation when speed is the key. There's also floating point emulation for unendowed PCs. And the altmath package gives you an extra burst of speed when you really need it.

A bundle of other features can save you programming time. There's inter-language calling support. So you can use existing library routines. Unsurpassed XENIX compatibility. And documentation that reviewers have praised for its clarity and thoroughness.

If Microsoft C amazes you, don't be surprised. After all, our C is the choice of the leaders. Companies like Lotus.® Ashton-Tate. And IBM.®

Microsoft C Compiler Version 3.0 for MS-DOS

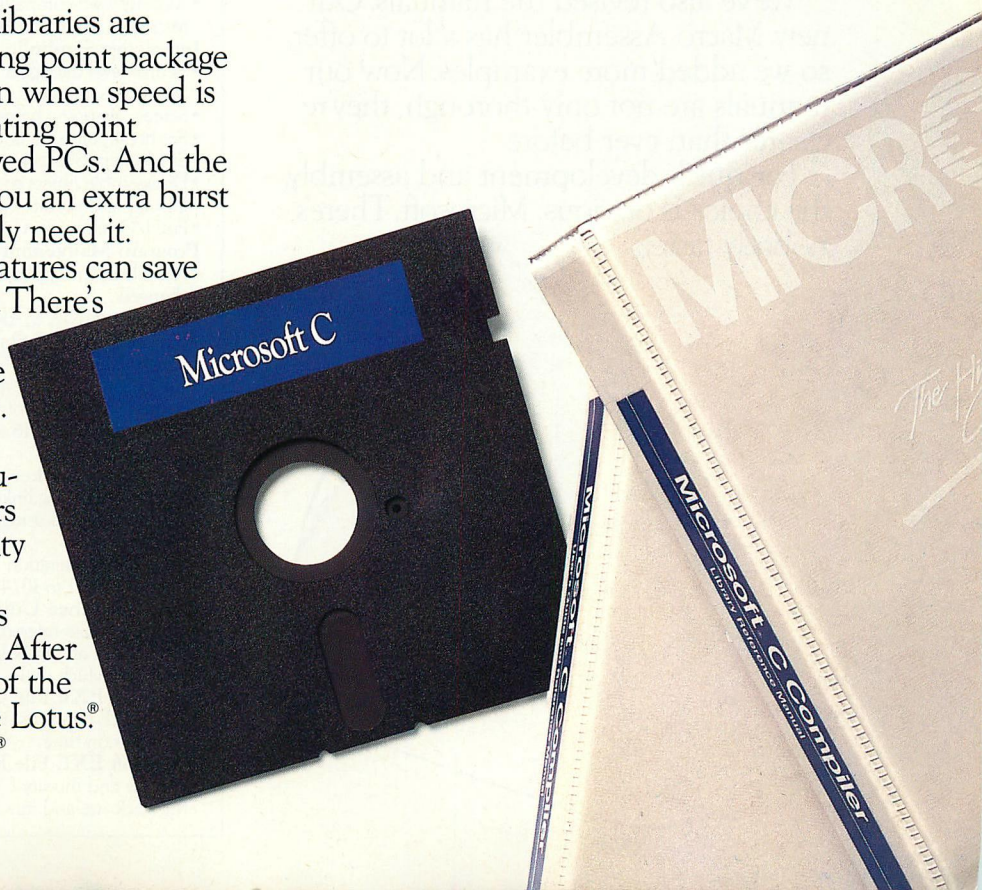
Microsoft C Compiler
- Produces compact code and fast executables.
- Implements register variables.
- Small, medium and large memory model libraries.
- Can mix models with NEAR and FAR pointers.
- Transport source and object code between MS-DOS and XENIX 286 operating systems.
- Library routines implement most of UNIX™ System V C library.
- Choose from three math libraries and generate in-line 8087/80287 instructions or floating point calls:
  - —Floating Point Emulator (utilizes 8087/80287 if installed).
  - —8087/80287 coprocessor support.
  - —Alternate math package provides extra speed without an 8087/80287.
- Link your C routines with Microsoft FORTRAN (version 3.3 or higher), Microsoft Pascal (version 3.3 or higher) or Microsoft Macro Assembler.
- Supports MS-DOS pathnames and input/output redirection.
- File sharing, record locking and file locking are supported.
- Do source level debugging with the Symbolic Debug Utility, available separately with Microsoft Macro Assembler.

Library Manager
- Create, organize and maintain your object module libraries created with Microsoft languages.

Object Code Linker
- Simple overlay linker combines relocatable object modules created using Microsoft languages into a single program.
- Link very large programs (over 1 megabyte) using overlays.

Microsoft EXE File Compression Utility
- A new utility to compress sequences of identical characters from an executable file and optimizes the relocation table.

Microsoft EXE File Header Utility
- Display and modify EXE file header, allowing you to tune the stack size and initial memory allocation.



Macro Assembler

The quickest. Bar none.

Our Macro Assembler has long been the most complete package on the market. Now it's also the fastest. Three times faster than before. And faster than anyone else. Period.

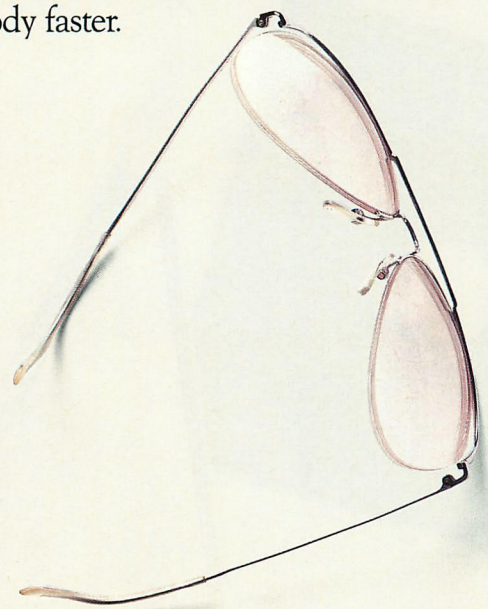
Of course, it's still the most powerful assembler on the market. It supports the standard 8086/8087 opcodes. And the new 186/286/287 instruction set. So you can make the most of the new machines.

Debugging is quicker, too. Thanks to our interactive symbolic debugger, SYMDEB. Now you can refer to variables and source code instead of getting lost in hex dumps. And this debugger also works with Microsoft languages like C, FORTRAN and Pascal. So now you can set breakpoints and trace execution—using source code for reference.

SYMDEB is just part of our complete set of utilities. Tools that make programming as fast as it should be. There are the linker and library managers you'd expect. Plus a new version of MAKE, our maintenance utility, with improvements like macro expansions and inference rules.

We've also revised the manuals. Our new Macro Assembler has a lot to offer, so we added more examples. Now our manuals are not only thorough, they're clearer than ever before.

For quick development and assembly, the choice is obvious. Microsoft. There's nobody faster.



The Macro Assembler's symbolic debugger lets you debug Microsoft FORTRAN programs at either the source or object code level. Set break points, observe the contents of variables and expressions, and examine the contents of the stack.

```
-
-u .10
10:             DO 10 I = 1,8191
11:       10    FLAGS(I) = .TRUE.
12:             DO 91 I=1,8191
13:             IF(.NOT. FLAGS(I))
14:             PRIME = I + I + 1
15:       200   FORMAT(1X,I6)
16:             COUNT = COUNT + 1
17:             K = I + PRIME
-bp .14 "u"
-g
14:             PRIME = I + I + 1
1AEF:0069 A16240          MOV
1AEF:006C 03C0            ADD
1AEF:006E 40              INC
1AEF:006F A36440          MOV
16:             COUNT = COUNT + 1
1AEF:0072 FF066040        INC
17:             K = I + PRIME
-?wo 4062
0001h  00000001  (1)  "."
-t
16:             COUNT = COUNT + 1
-=
```

Microsoft Macro Assembler Version 4.0 for MS-DOS

Macro Assembler
- Fastest macro assembler for MS-DOS computers.
- Supports the 8086/8087/8088 and the 186/286/287.
- Define macros.
- Conditional assembly.
- Optional case sensitivity for symbols.
- 100% upward compatibility from earlier versions of both the Microsoft and IBM Macro Assemblers.

Interactive Symbolic Debug Utility
- Source level debugger for programs written in Microsoft Macro Assembler, C Compiler, FORTRAN, and Pascal.
- Screen swapping helps debug highly visual applications.
- Set breakpoints on line numbers and symbols.
- Single step to follow program execution.
- Disassemble object code.
- Display and modify values.
- Full I/O redirection.

Program Maintenance Utility
- Rebuilds your applications after your source files have changed.
- Similar to UNIX MAKE utility.
- Supports macro definitions and inference rules.

Library Manager
- Create, organize and maintain your object module libraries created with Microsoft languages.
- Set page size from 16 to 32678, to create compact and granular libraries.

Object Code Linker
- Simple overlaying linker combines relocatable object modules created using Microsoft languages into a single program.
- Load Map generation.
- Specify from 1 to 1024 segments.

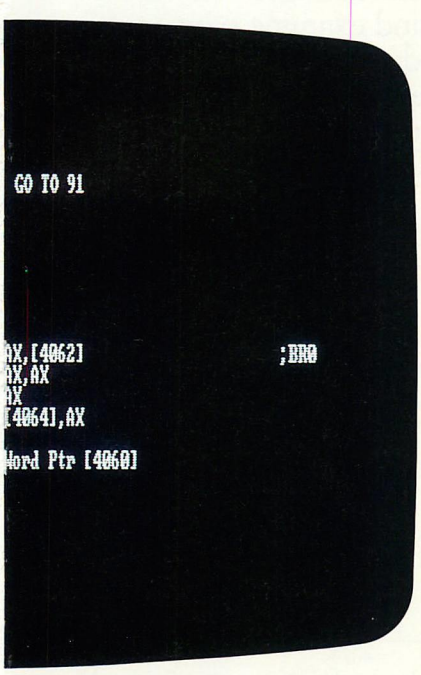
Cross-Reference Utility
- Creates a cross-reference listing of the definitions and locations of all symbols used in an assembly language program, which makes debugging programs easier.

Microsoft EXE File Compression Utility
- Packs EXE files for smaller size on disk and faster loading at execution time.

Microsoft EXE File Header Utility
- Display and modify EXE file header, allowing you to tune the stack size and initial memory allocation.

FORTRAN

The overwhelming favorite.



View the FORTRAN source code. Set a break point at line #14. Run the program **(g)** *and use the expression evaluator* **(?)** *to examine the contents of a variable. Then use the trace command* **(t)** *to observe the program flow.*

How did Microsoft FORTRAN get so popular?

It could be the mainframe compatibility. Our compiler makes porting applications a cinch with overlays and the ANSI features you need.

It could be our support for arrays and COMMON blocks larger than 64K. So you can tackle mainframe-size problems.

It might be the shelves and shelves of third party support libraries. No other FORTRAN comes close.

It could be the extensive math support. Our collection of math libraries is simply the largest available. Tackle real problems with direct 8087 support or emulation. Use IEEE floating point or—for extra speed—the altmath package.

It could be the comprehensive set of utilities. A powerful linker and library manager combination. Plus tools like EXEMOD and EXEPACK. Standard.

It could be the XENIX and MS-DOS source-level compatibility. Or the direct interlanguage calling to Microsoft C, Pascal, and Assembler. Or the ability to work with our Macro Assembler's symbolic debugger.

It could be the value. Nobody offers a FORTRAN package this complete at this low a price.

Why is Microsoft FORTRAN the most popular FORTRAN?

All the above.

Microsoft FORTRAN Compiler Version 3.3 for MS-DOS and XENIX 286

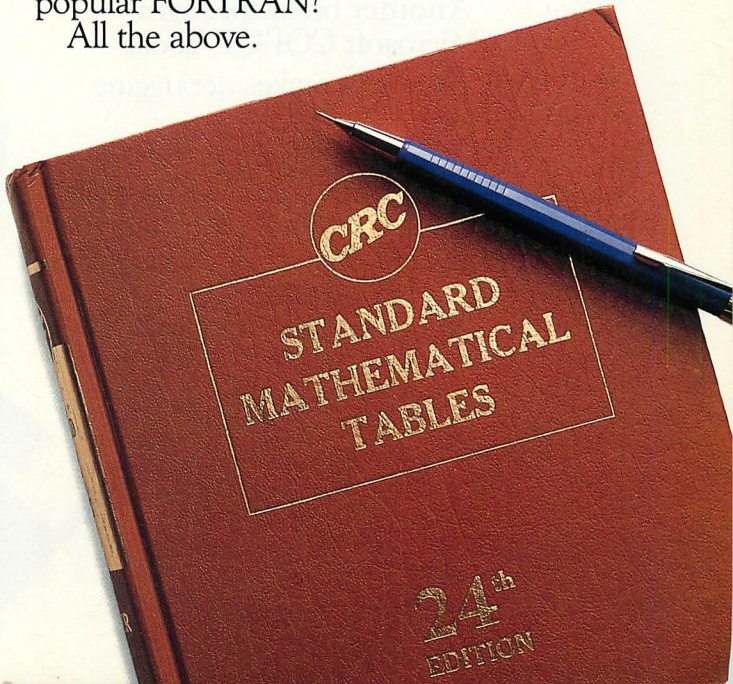
Microsoft FORTRAN Compiler
- Implements most ANSI 77 standard features, plus extensions.
- Easily port mainframe/minicomputer programs with little or no modification.
- Overlay support in the compiler and linker.
- Common blocks and arrays greater than 64K.
- Supported by the largest number of third party libraries.
- Includes a full set of math libraries to select from:
  - —8087/80287 emulation.
  - —8087/80287 coprocessor support.
  - —Floating Point without 8087/80287.
  - —BCD Floating Point.
- Conditional compilation.
- Link your FORTRAN routines with Microsoft C Compiler (version 3.0 or higher), Microsoft Pascal (version 3.3 or higher), and Microsoft Macro Assembler.
- MS-DOS 3.1 network support and IBM local area network support.
- Source code compatible between MS-DOS and XENIX 286.
- Do source level debugging with the Symbolic Debug Utility, available separately with Microsoft Macro Assembler.

Object Code Overlay
- Simple overlay linker combines relocatable object modules created using Microsoft languages into a single program.
- Link very large programs (over 1 megabyte) using overlays.

Library Manager
- Create, organize and maintain your object module libraries created with Microsoft languages.

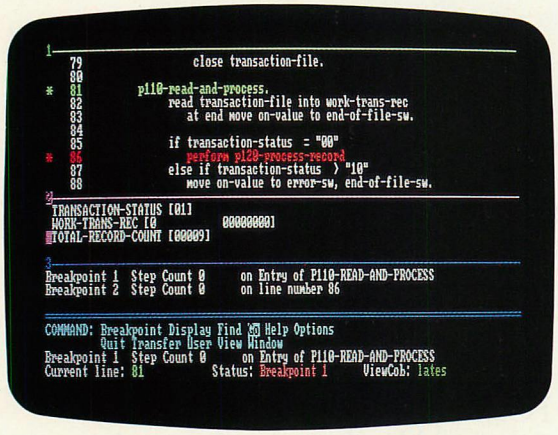
Microsoft EXE File Compression Utility (MS-DOS only)
- A utility to pack EXE files for smaller size on disk and faster loading at execution time.

Microsoft EXE File Header Utility (MS-DOS only)
- A utility that allows you to display and modify the fields in EXE file headers.



COBOL

The interactive edge.



Microsoft COBOL gives programs a new look. With dazzling support for interactive programs, and more. Our new COBOL Compiler brings applications to life in several ways.

Our extended screen section lets you create programs that you'd never thought could be written in COBOL. Quickly, easily.

Performance is top notch as well. Our ISAM lets your applications blaze through files. After all, our ISAM is the fastest on the micro market.

Of course, Microsoft COBOL complies with the ANSI standard. Amazing performance, without runtime license fees. No wonder our COBOL is the choice of manufacturers like IBM, AT&T, DEC, HP and Wang.

Another breakthrough: Microsoft COBOL Tools.

Only Microsoft makes debugging this easy.

Our COBOL Tools is the perfect companion to our COBOL Compiler. A complete set of utilities. Tools that make debugging and maintenance easier than you'd thought possible.

The star of the show is ViewCOB, our advanced interactive debugger. ViewCOB lets you control and examine programs easily. Open windows on variables and procedures while watching the source code execute. ViewCOB is simply the most advanced COBOL debugger you can get.

Microsoft COBOL and COBOL Tools. An unbeatable team.

Microsoft COBOL Compiler Version 2.1 for MS-DOS and XENIX 286

Interactive extended screen section
- Cursor positioning, auto skip, and automatic data field formatting.
- ACCEPT or DISPLAY a screenful of data with a single statement.

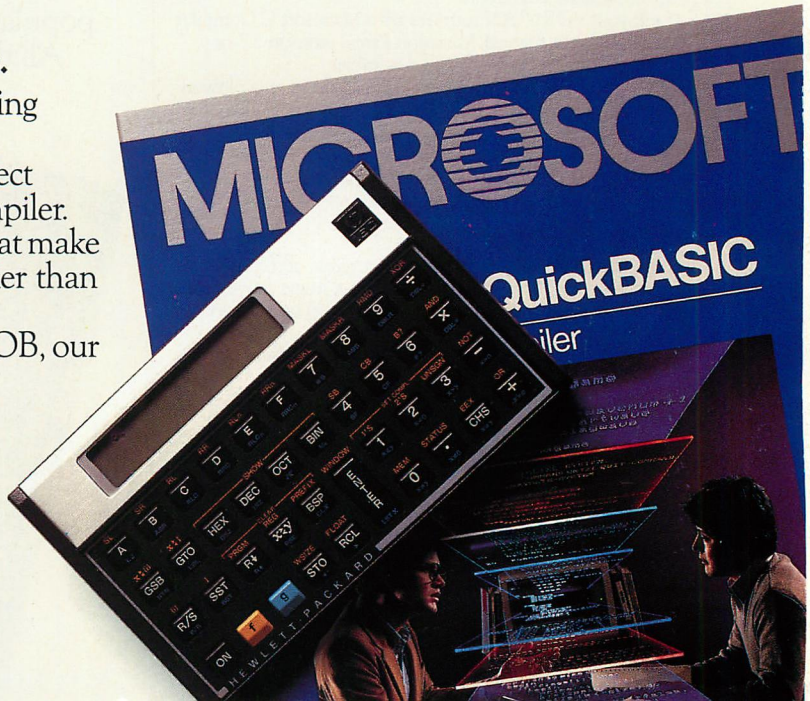
Fast multi-key ISAM
- Split keys, alternate keys, duplicate keys.
- Benchmark results of 2500 reads, writes and rewrites to an ISAM file.

	Microsoft COBOL	Micro Focus native code	Ryand McFarland COBOL 2.0
Seconds	846	4073	1177

Source code compatible between MS-DOS and XENIX 286.

Microsoft COBOL Tools for MS-DOS and XENIX 286
- Cross reference utility speeds program development.
- Menu generator allows you to use Microsoft Word style menus in your program.
- Mouse interface allows you to create programs that use the mouse (MS-DOS only).

Advanced interactive debugger
- Use trace, single step, and execution history to follow the program flow.
- Observe the contents of variables and memory while the program is executing.
- Set breakpoints and change the contents of variables.
- Trap fatal runtime errors.
- Use the menu driven windowing user interface with on-line help.



Pascal

When you've outgrown the others.

Only Microsoft Pascal is powerful enough to push the outer limits of your PC. With more features than any other Pascal compiler.

Microsoft Pascal handles large programs with ease. No 64K boundaries—use multiple code and data segments up to a megabyte. Create your own libraries of pre-compiled Pascal modules. Separately-compiled modules can be overlayed or linked together into one file.

Our Pascal comes complete with the BCD and 8087 math libraries you'd expect. Including an IEEE floating point emulator. And Microsoft Pascal is completely compatible with IBM's Local Area Network and MS-DOS Networking. Added features without added costs.

Microsoft Pascal also supports direct interlanguage calling to modules written in Microsoft C, or Microsoft FORTRAN or assembly language. And it's compatible with our Macro Assembler's symbolic debugger. So you can track down those subtle logic errors with breakpoints instead of guesswork.

Microsoft Pascal. Nobody does it better.

Microsoft Pascal Compiler Version 3.3 for MS-DOS and XENIX 286

Microsoft Pascal Compiler
- Separate module compilation.
- Large program support; up to 1 megabyte code and multiple data segments.
- Overlay support.
- Contains four math libraries to choose from:
  - 8087/80287 coprocessor support.
  - Fast IEEE floating point.
  - 8087/80287 floating point emulation.
  - BCD decimal math.
- Link in your routines or third party software routines written in Microsoft FORTRAN (version 3.3 or higher), Microsoft C Compiler (version 3.0 or higher) or Microsoft Pascal (version 3.3 or higher), or Microsoft Macro Assembler.
- Source code compatible between MS-DOS and XENIX 286.
- Supports file sharing and record and file locking.
- Supports MS-DOS pathnames and input/output redirection.
- Do source level debugging with the Symbolic Debug Utility, available with the Microsoft Macro Assembler.

Library Manager
- Create, organize and maintain object module libraries created with Microsoft languages.

Object Code Linker
- Simple overlay linker combines relocatable object modules created using Microsoft languages into a single program.
- Link very large programs (over 1 megabyte) using overlays.

Microsoft EXE File Compression and File Header Utility (MS-DOS only)
- Compress, modify and examine executable files and their headers.

Microsoft QuickBASIC

BASIC just got faster.

Microsoft's new QuickBASIC Compiler gives your programs an extra burst of speed. Without sacrificing BASICA compatibility. Your compiled programs will run just like before, only faster. Three to ten times faster. With little or no modification.

QuickBASIC makes structured programming a snap. New extensions like alphanumeric labels make programming easier too. And separately compiled subprograms let you test and compile individual routines one at a time.

Microsoft QuickBASIC. All the features of a compiler, with BASICA compatibility to boot.

Microsoft QuickBASIC Compiler Version 1.0 for IBM PC and Compatible Computers

BASICA compatibility
- Sound statements including SOUND and PLAY.
- Graphics statements including WINDOW, VIEW, DRAW, GET, PUT, LINE, CIRCLE, LOCATE and SCREEN.

Results of the Sieve benchmark	BASICA	QuickBASIC
seconds per iteration	71	0.5

Structured programming support
- Subprograms can be called by name and passed parameters. Both local and global variables are supported.
- Multi-line functions can be called by name and return a value.
- BASICA structures are supported including WHILE/WEND, IF/THEN/ELSE, FOR/NEXT, GOSUB/RETURN, and event handling.

Alphanumeric labels
- Can be used to make your programs more readable. Line numbers are not required but are supported for BASICA compatibility.

Modular programming support
- Separate compilation allows you to create compiled BASIC libraries to use and reuse in your programs.
- Named common gives you control of data flow between individual modules.

Large program support
- Code can use up to available memory.
- Data can use up to 64K RAM.

LISP

The language of Artificial Intelligence.

What's Microsoft LISP got going for you? It runs significantly faster than the competition. And this new version adds several advanced libraries. Over 400 Common LISP functions, macros and special forms. Most implemented in machine code.

If you're putting AI on your PC, Microsoft LISP is your language.

muMATH

Mainframe math on your PC.

From solving equations to high precision calculations, muMATH is the ticket.

Microsoft muMATH handles tasks from algebra to calculus and vector analysis. Now your PC can do numeric analysis based on symbolic expressions. And give you exact answers.

If you crunch numbers—or equations—muMATH is just what the CPU ordered.

Sort

Versatility without compromise.

Microsoft Sort makes fast sorting easy.

A powerful, programmable interpreter lets you choose ASCII, EBCDIC or custom sequences. Sort handles files from any Microsoft language. Without limiting the size of your file, the number of search keys, or your record length.

Microsoft Sort. The speed and power you need. Easily.

The leadership edge.

No other languages are backed by as massive a collection of third-party software. Here are just a few of the companies that speak our languages: **Blaise Computing, Graphic Software Systems, Greenleaf Software, Inc., IMSL, Media Cybernetics, Microrim, Numerical Analyst Group, Phoenix Software, Solution Systems, Spruce Technology, Trio Systems, and Virtual Microsystems.**

This is just a sample. For a complete list, call Microsoft at the number below.

An added value for our readers.

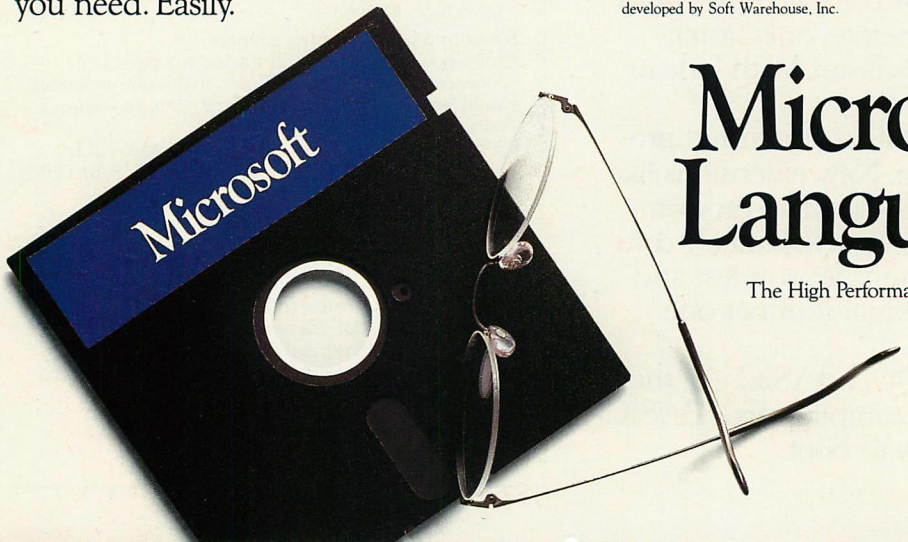
We're proud of the way our family works together, so we're offering a $25 rebate on our Macro Assembler when you purchase Microsoft C, Pascal or FORTRAN.*

For more details, upgrade information or the name of your nearest Microsoft dealer, call toll free (800) 426-9400. In Washington State and Alaska, call (206) 828-8088. In Canada, (800) 387-6616.

Microsoft Corporation Bellevue, Washington USA	Microsoft Ltd. Reading ENGLAND
Microsoft GmbH München DEUTSCHLAND	Microsoft SARL Paris FRANCE
Microsoft Canada Inc. Toronto CANADA	QNIX Microsoft Seoul KOREA
Microsoft AB Stockholm SWEDEN	Microsoft Far East Tokyo JAPAN
Microsoft Pty Sydney NSW AUSTRALIA	Microsoft SpA Milano ITALIA

*Rebate offer valid only in the United States.

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Microsoft® Languages

The High Performance Software™

0286 Part Number 098-400-201

WATCH YOUR LANGUAGES!

. . . with MICROSOFT®

The choice of language software is one of the most critical decisions you can make. Now the choice is clear. Microsoft, an early pioneer in the development of high quality personal computer software, has created some of the most advanced and efficient language compilers and interpreters available today. We at Programmer's Connection are pleased to be your source for the complete line of Microsoft Languages and support products. So choose Microsoft and watch your language improve dramatically.

Microsoft is a trademark of Microsoft Corporation.

● Microsoft C Compiler

	LIST	OURS
	395	**259**

High performance C compiler that supports register variables, granular runtime libraries and automatic optimization to produce very compact and fast native code. There is an extensive library that implements most UNIX System V functions. It supports small, medium and large memory models, library mix models with NEAR and FAR pointers, DOS pathnames, I/O redirection, file sharing and record locking. There are three math libraries consisting of a floating point emulator, 8087/287 coprocessor support and an alternate package for added speed on systems without a math coprocessor. The system is source code compatible between DOS and XENIX and comes with runtime libraries, an overlay linker and a library manager. Object modules may be linked with those produced by Microsoft Fortran, Pascal and Macro Assembler (MASM).

● Microsoft COBOL Compiler

	LIST	OURS
	700	**495**
for XENIX	995	**795**

ANSI standard COBOL compiler featuring an extremely fast ISAM facility, an interactive, extended screen section and many user oriented features. It accepts numbers up to 18 digits long and maintains internal accuracy of up to 30 digits. This native code compiler generates standard object modules which can be linked to create executable programs. Source code is compatible between XENIX and MS-DOS. Use the separately available COBOL Tools for source-level debugging of COBOL programs. No run-time license fees.

● Microsoft COBOL Tools

	LIST	OURS
	350	**229**
for XENIX	450	**359**

Set of COBOL utilities including cross reference utility, menu generator, mouse interface and ViewCOB, an advanced, interactive source level debugger. The debugger provides the ability to trace, single-step and set breakpoints in COBOL source programs as well as observe or change the contents of variables during program execution. Its user interface is window-oriented with menu-driven commands and on-line help.

● Microsoft FORTRAN Compiler

	LIST	OURS
	350	**229**
for XENIX	495	**389**

Native code generating FORTRAN compiler based on the ANSI x3.9 1978 standard. It supports complex numeric and double precision complex numeric data types as well as character substrings. Arrays and COMMON blocks may exceed 64K and are limited only by available memory. There are four math libraries consisting of a floating point emulator, 8087/287 coprocessor support, a decimal math package and an alternate package for added speed on systems without a math coprocessor. Double precision calculations are accurate to 14 significant digits. It supports file sharing and record and file locking for multiuser and networked systems. The system is source code compatible between DOS and XENIX and comes with a compiler, runtime libraries, an overlay linker and a library manager. Object modules may be linked with those produced by Microsoft C, Pascal and Macro Assembler (MASM). Use the SYMDEB debugger that comes with the separately available Microsoft Macro Assembler for source-level debugging of Fortran programs.

● Microsoft LISP

	LIST	OURS
New version	250	**189**

Advanced implementation of the LISP language that supports over 400 Common LISP commands, macros, special forms and control variables. It provides extremely fast performance and can be used to create exceptionally compact programs and data files. The system takes full advantage of up to 512K memory and features an efficient, two-pass garbage collector that performs automatic, dynamic-memory management over all data spaces. The package includes a powerful, symbolic LISP debugger that features a multi-level break-and-trace facility and an execution profiler. There are separate windows for editing and debugging. Comes with an interactive tutorial.

● Microsoft Macro Assembler (MASM)

	150	**109**

Very fast, standard PC macro assembler that fully supports the 8088, 80186 and 80286 instruction sets and their corresponding math coprocessors. It's completely upward compatible with the IBM Macro Assembler and comes complete with a fast MS-DOS overlay linker, a library manager, a MAKE utility, a cross reference utility and excellent documentation. New utilities include EXEPACK, an EXE file compression utility and EXEMOD, an EXE file header utility. Also featured is SYMDEB, an interactive symbolic program debugger that supports source-level debugging of Microsoft C, Fortran and Pascal programs. It supports source line single-stepping and breakpointing, full I/O redirection, stack tracing and shell escapes for executing DOS commands.

● Microsoft muMATH

	300	**219**

Symbolic mathematics system for efficiently and accurately performing true algebraic and analytic operations. Math expressions are operated upon symbolically allowing such operations as expansion over common denominators, simplification of expressions and symbolic integration. Math packages are provided for matrix manipulation, limits, series summation, differential equations, vector algebra, calculus and much more. Extremely precise calculations may be obtained with this system. Includes muSIMP, the general purpose language used to develop muMATH.

● Microsoft Pascal Compiler

	300	**219**
for XENIX	495	**389**

Pascal compiler that exceeds the proposed ISO and ANSI level 0 standards and compiles to fast, efficient native machine code. There are four math libraries consisting of a floating point emulator, 8087/287 coprocessor support, a decimal math package and an alternate package for added speed on systems without a math coprocessor. Data beyond the default 64K data segment can be accessed using the compiler's long heap allocator. It supports file sharing and record and file locking for multiuser and networked systems. There is overlay support allowing program modules to be loaded only when needed. The system is source code compatible between DOS and XENIX and comes with a compiler, runtime libraries, a linker and a library manager. Object modules may be linked with those produced by Microsoft C, Fortran and Macro Assembler (MASM). Use the SYMDEB debugger that comes with the separately available Microsoft Macro Assembler for source-level debugging of Pascal programs.

● Microsoft QuickBASIC Compiler

	99	**79**

Complete BASIC compiler with separate module compilation that allows creation of programs greater than 64K. It's BASICA compatible, so you can use your interpreter to design, write and test your program, then compile it into true IBM PC native code for 3 to 10 times faster execution. It supports local and global variables within subprograms and allows the use of alphanumeric labels and optional lines numbers for greater readability. There are also functions for creating sophisticated screen graphics, music and sound effects. Requires 256K memory.

● Microsoft Sort

	195	**149**

Generalized file sort and manipulation utility that handles files from any Microsoft language. Comes with both stand-alone and COBOL-hosted versions. Can merge files, select a specified subset of files and compare records. There's no limit on the number or size of keys.

● Microsoft Windows

	99	**75**

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artificial intelligence

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Experteach by Intelliware	*Complete System*	475	**389**
EXSYS *Expert System Development Software*		395	**339**
GCLISP *Golden Common LISP* by Gold Hill	*All models*	CALL	**CALL**
Insight I by Level Five Research	*AI Primer*	95	**75**
Insight II by Level Five Research		485	**389**
LISP by Microsoft	*New Common Lisp*	250	**189**
Methods *Smalltalk-based Prototyping* by Digitalk		250	**219**
Prolog-86 from Solution Systems		125	**CALL**
Prolog-86 Plus from Solution Systems	*New*	250	**CALL**
Small-X by Kaplan	*New*	CALL	**CALL**
UNXLISP by Cybermetrics	*New*	70	**59**

assemblers and debuggers

8088 Assembler *w/Z-80 Translator* by 2500 AD		100	**89**
Advanced Trace-86 by Morgan	*with ASM Interpreter*	175	**139**
Codesmith-86 *Debugger* by Visual Age		145	**109**
Cross Assemblers from 2500AD	*Over 25 varieties*	CALL	**CALL**
Microsoft Macro Assembler *with utilities*		150	**109**
Periscope I *Debugger* by Data Base Decisions		295	**269**
Periscope II by Data Base Decisions		145	**129**
The PROFILER by DWB Associates	*Includes source*	125	**109**
Turbo EDITASM *Fast Assembler* by Speedware		99	**85**
Visible Computer: 8088 by Software Masters		70	**59**

basic language

BetterBASIC by Summit Software	*Now BASICA Compatible*	200	**169**
8087 Math Support		99	**89**
Btrieve Interface	*Used with Btrieve*	99	**89**
Run-time Module		250	**239**
Microsoft QuickBASIC Compiler	*BASICA Compatible*	99	**79**
Professional BASIC by Morgan		99	**79**
8087 Math Support		50	**47**
True Basic from Addison-Wesley		150	**109**
Run-time Module		500	**459**

blaise products

Asynch Manager *for C or Pascal*		175	**139**
C Tools		125	**109**
C Tools 2		100	**89**
Combination package	*Special Price*	175	**149**
Exec *Program Chainer*		95	**84**
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Turbo POWER TOOLS *for Turbo Pascal*		100	**89**
View Manager *for C or Pascal*		275	**209**
with Source Code	*Special Price*	295	**239**

c compilers

C-86 Compiler by Computer Innovations		395	**299**
Datalight C Compiler		60	**49**
DeSmet C Compiler w/Source Debugger		159	**145**
Eco-C Development System by Ecosoft	*New version*	125	**89**
Lattice C Compiler from Lattice		500	**CALL**
Let's C Compiler by Mark Williams		75	**69**
with csd Source Level Debugger		150	**129**
MWC-86 by Mark Williams	*Limited Quantity Special*	495	**289**
Microsoft C Compiler		395	**259**
Wizard C by Wizard Systems	*Includes lint*	450	**369**

c interpreters

C-terp by Gimpel Software	*Specify compiler interface*	300	**239**
Instant C by Rational Systems		500	**379**
Interactive C by IMPACC Associates	*New*	249	**219**
Run/C Lite from Lifeboat		150	**99**
Run/C Professional from Lifeboat		250	**189**

c utilities

Call us for availability of specific compiler interfaces.

		LIST	OURS
Application Programmer's Toolkit by Shaw American		395	**339**
Basic-C *Library* by C Source		175	**139**
Btrieve *ISAM File Mgr*	*See SoftCraft Section*	250	**199**
C Essentials by Essential Software	*New*	100	**85**
C-Food Smorgasbord by Lattice		150	**109**
C-lib by vance info systems		195	**125**
C Power Packs by Software Horizons		CALL	**CALL**
c-tree by FairCom	*Includes source*	395	**329**
C Utility Library by Essential Software		185	**139**
C Windows by Syscom	*New*	100	**89**
C Wings by Syscom	*New*	50	**45**
Curses *Screen Manager*	*See Lattice section*	125	**109**
dBC *dBase File Manager for C*	*See Lattice section*	250	**199**
db-VISTA *Single-User DBMS* by Raima		195	**159**
with Source Code		495	**429**
db-VISTA *Multi-User DBMS* by Raima		495	**429**
with Source Code		990	**849**
Entelekon C Function Library		130	**115**
Entelekon C Windows		130	**115**
Entelekon Superfonts for C		50	**45**
Entelekon Combination Package		200	**175**
Essential Graphics by Essential Software. *No royalties*		250	**219**
Flash-up Windows by Software Bottling of NY	*New*	75	**69**
GraphiC by Scientific Endeavors		250	**209**
The Greenleaf Functions by Greenleaf Software		185	**139**
Greenleaf Comm Library by Greenleaf Software		185	**139**
The HAMMER by OES Systems		195	**179**
H.E.L.P. by Everest Solutions		CALL	**CALL**
MetaWINDOWS by Metagraphics		150	**139**
Multi-Halo by Media Cybernetics	*Royalties*	250	**189**
On-line Help from Opt-Tech Data	*New*	149	**119**
PANEL by Roundhill	*Library Source Available*	295	**234**
PC Lint by Gimpel Software		139	**109**
Polytron C Library		99	**79**
Scientific Subroutine Library for C by Peerless		175	**139**
TopView Toolbasket	*See Lattice Section*	250	**199**
View Manager for C	*See Blaise Section*	275	**209**
Vitamin C by Creative Programming		150	**139**
Windows for C by Vermont Creative Software		195	**139**
Windows for Data	*Includes Windows for C*	295	**199**
Zview by Data Management Consultants	*New*	245	**199**

computer innovations products

C-86 Optimizing Compiler		395	**299**
C to dBase		150	**139**
CI Probe *Source Level Debugger*		225	**199**
CI ROM Pack *for C-86*		195	**149**
Introducing C	*C Interpreter*	125	**109**

fortran compilers and utilities

Microsoft Fortran	*Links with Microsoft C*	350	**229**
RM/Fortran by Ryan-McFarland		595	**399**
ACS Time Series by Alpha Computer Service	*New*	495	**429**
Btrieve *ISAM File Mgr*	*See SoftCraft Section*	250	**199**
For-Winds by Alpha Computer Service	*New*	90	**79**
Forlib-Plus by Alpha Computer Service		70	**59**
Multi-Halo by Media Cybernetics	*Royalties*	250	**189**
PANEL *Screen Designer* by Roundhill		295	**234**
PC Fortran Tools by Stat Com Systems	*New*	179	**159**
PolyFortran Tools by Polytron		179	**139**
Scientific Subroutine Library by Peerless		175	**139**
Scientific Subroutine Package by Alpha Computer	*New*	295	**259**
The Statistician by Alpha Computer Service		295	**259**
Strings & Things by Alpha Computer Service		70	**59**

lattice products

All products in this section have Lattice serial numbers. These products receive support and updates directly from Lattice Inc., the company that actually developed the Lattice C compiler.

Lattice C is in stock and ready for shipment.

Lattice C Compiler		500	**CALL**
C Cross Reference Generator		50	**39**
C-Food Smorgasbord *Function Library*		150	**109**
C-Sprite *Source Level Debugger*		175	**139**
Curses *Screen Manager*		125	**99**
with Source Code		250	**199**
dBC *dBase File Manager for C*		250	**199**
with Source Code		500	**395**
LMK *Make Facility*		195	**149**
RPG II Compiler	*New*	750	**595**
SecretDisk *Disk Security*	*New*	60	**49**
SideTalk *Resident Communications*	*New*	120	**95**
Text Mgmt Utilities (GREP/DIFF/ED/WC/Extract/Build).		120	**95**
TopView Toolbasket *Function Library*		250	**199**
with Source Code		500	**395**

logitech modula-2 products

MODULA-2/86 Compiler		89	**79**
MODULA-2/86 Compiler *with 8087*		129	**109**
MODULA-2/86 Compiler *with 512K*		189	**159**
MODULA-2 Editor		59	**49**
MODULA-2 Runtime Debugger		69	**59**
MODULA-2 Source Package		179	**155**
MODULA-2 Utilities Package		49	**45**

for the IBM-PC/XT/AT and compatibles.

micro focus cobol products

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COBOL Workbench	4000	**3599**
Level II COBOL	1500	**1269**
COMATH	200	**169**
FORMS-2	300	**269**
Level II Animator	1200	**995**
Level II FILESHARE	800	**659**
Level II SOURCEWRITER	2000	**1689**
Micro/SPF	175	**159**
Professional COBOL	3000	**2395**

microsoft products

		LIST	OURS
Microsoft BASIC Interpreter *for Xenix*		350	**279**
Microsoft C Compiler		395	**259**
Microsoft COBOL Compiler		700	**495**
Microsoft COBOL Compiler *for Xenix*		995	**795**
Microsoft COBOL Tools	*with COBOL Source Debugger*	350	**229**
Microsoft COBOL Tools *for Xenix*		450	**359**
Microsoft Fortran Compiler	*Links with Microsoft C*	350	**229**
Microsoft Fortran Compiler *for Xenix*		495	**389**
Microsoft LISP	*New Common Lisp*	250	**189**
Microsoft Macro Assembler *with utilities*		150	**109**
Microsoft muMath	*Includes muSIMP*	300	**219**
Microsoft Pascal Compiler	*Links with MicrosoftC*	300	**219**
Microsoft Pascal Compiler *for Xenix*		495	**389**
Microsoft Sort		195	**149**
Microsoft QuickBASIC Compiler		99	**79**
Microsoft Windows		99	**75**

other languages

	LIST	OURS
Janus/ADA C Pack by R&R Software	95	**89**
Janus/ADA D Pack by R&R Software	900	**699**
PC/Forth by Laboratory Microsystems	150	**119**
PC/Forth+ by Laboratory Microsystems	250	**209**

phoenix products

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Pasm86 *Macro Assembler*		295	**179**
Pfantasy Pac	*Pfinish,Pfix+,Plink+,Pmaker,Pmate,Ptel*	1295	**895**
Pfinish *Performance Analyzer*		395	**229**
Pfix-86 Plus *Symbolic Debugger*		395	**229**
Plink-86 *Overlay Linker*		395	**229**
Plink-86 Plus *Overlay Linker*		495	**359**
Pmaker *Program Development Manager*		195	**139**
Pmate *Macro Text Editor*		225	**139**
Pre-C *Lint Utility*		395	**229**
Ptel *Binary File Transfer Program*		195	**129**

polytron products

		LIST	OURS
Polytron C Library I		99	**79**
Polytron C Beautifier	*New*	49	**45**
PolyFortran Tools		179	**139**
PolyLibrarian *Library Manager*		99	**79**
PolyLibrarian II *Library Manager*		149	**129**
PolyMake *UNIX-like Make Facility*		99	**79**
PolyOverlay *Overlay Optimizer*		99	**79**
Polytron PowerCom Communications	*New*	179	**139**
PolyXREF *Cross Reference Utility*	*Complete system*	219	**179**
PolyXREF	*Support for one language only*	129	**109**
PVCS *Polytron Version Control System*		395	**359**
PVMFM *Polytron Virtual Memory File Manager*		199	**179**

softcraft products

		LIST	OURS
Btrieve *ISAM File Manager*	*No Royalties*	250	**199**
Btrieve/N *for Networks*		595	**469**
Rtrieve *Report Generator for Xtrieve*		85	**79**
Rtrieve/N *Report Generator for Xtrieve/N*		175	**159**
Xtrieve *Query Utility for Btrieve*		195	**169**
Xtrieve/N *Query Utility for Btrieve/N*		395	**299**
OPT-Tech Sort by Opt-Tech Data Processing		99	**84**

stsc apl products

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APL*PLUS/PC System	595	**449**
APL*PLUS/PC Tools Vol 1	295	**239**
APL*PLUS/PC Tools Vol 2	150	**129**
Financial/Statistical Library	275	**219**
Pocket APL	95	**79**
STATGRAPHICS	695	**539**
Btrieve *ISAM File Manager* — *See SoftCraft Section*	250	**199**

text editors

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Brief from Solution Systems		195	**CALL**
Epsilon by Lugaru	*Multitasking*	195	**165**
FirsTime for Turbo by Spruce Technology		75	**69**
KEDIT by Mansfield Software Group	*Like Xedit*	125	**109**
SPF/PC by Command Technology Corp		195	**165**
Vedit by CompuView		150	**119**
Vedit Plus by CompuView		225	**180**
XTC Text Editor by Wendin	*Includes source*	99	**89**

turbo pascal and utilities

		LIST	OURS
ALICE: The Personal Pascal by Software Channels		95	**85**
FirsTime for Turbo by Spruce Technology		75	**69**
Flash-up Windows by Software Bottling of NY	*New*	75	**69**
Multi-Halo by Media Cybernetics	*Royalties*	250	**ALL**
On-line Help from Opt-Tech Data	*New*	149	**119**
Screen Sculptor by Software Bottling		125	**99**
Turbo ASYNCH by Blaise Computing		100	**89**
Turbo DATABASE TOOLBOX by Borland International		55	**49**
Turbo EDITOR TOOLBOX by Borland International		70	**55**
Turbo Extender by TurboPower Software	*New*	85	**75**
Turbo GAMEWORKS TOOLBOX by Borland International		70	**55**
Turbo GRAPHIX TOOLBOX by Borland International		55	**39**
Turbo LIGHTNING by Borland International		99	**79**
Turbo PASCAL by Borland International		70	**49**
Turbo PASCAL *w/8087 or BCD*		110	**79**
Turbo PASCAL *w/8087 & BCD*		125	**85**
Turbo POWER TOOLS by Blaise Computing		100	**89**
Turbo Professional by Sunny Hill Software	*New*	70	**59**
Turbo TUTOR by Borland International		35	**29**
TurboRef by Gracon Services		50	**45**
TurboPower Utilities by TurboPower Software		95	**89**
TurboWindow by MetaGraphics		50	**45**
XTC *Text Editor* by Wendin		99	**89**

wendin products

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Operating System Toolbox	*Build your own OS*	99	**89**
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xenix system v by sco

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Xenix Operating System	*Specify XT or AT*	495	**449**
Xenix Text Processing Package	*Specify XT or AT*	195	**179**
Complete Xenix System	*Specify XT or AT*	1085	**969**

xenix languages and utilities

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APL*PLUS/UNX System by STSC	*For AT Xenix*	995	**795**
Btrieve *ISAM File Manager* by SoftCraft		595	**469**
c-tree by FairCom	*Includes C source code*	395	**329**
Informix by SCO		995	**839**
Lyrix by SCO		595	**489**
Microsoft Languages	*See Microsoft Section*	-	-
Networks for XENIX by SCO	*New*	CALL	**CALL**
PANEL *Screen Designer* by Roundhill	*For AT Xenix*	595	**539**
SCO Professional by SCO	*Complete Lotus clone*	795	**695**
SQL Informix by SCO		995	**839**
Windows for C by Vermont Creative Software		395	**359**
Windows for Data by Vermont Creative Software		595	**539**

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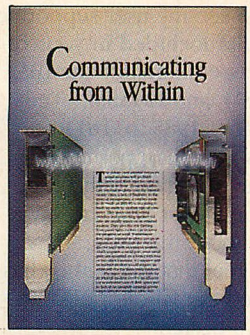
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STRAIGHT TALK

I write to you regarding "Communicating from Within" (Augie Hansen, September 1985, p. 60). It is a very big task to write a survey article with as much in it as yours. I won't nitpick, but I do feel compelled to object to table 2 indicating an absence of call progress reporting on the ProModem 1200B. Every Prometheus modem has call progress reporting. We indicate connect, ring, no carrier, error, dial complete, busy-redialing, busy-will redial in 30 seconds, no response to dial, disconnect, carrier lost, and invalid command. (Information on these statements appears on pages 5 through 10 of the manual.)

The scorecard section indicates that the ProModem 1200B has no self-test mode. Self-test *is* included in the 1200B and all of our modems; it is explained on pages 4-12 to 4-14 of the manual.

As the least expensive modem tested, we feel the ProModem 1200B came out ahead of most of the competition and are grateful we were included.

Tom McShane
Chairman
Prometheus Products, Inc.

Errors of fact in any article are regrettable. We authors try to avoid errors, but they do occur. Mr. McShane's letter sets the record straight regarding the ProModem 1200B result codes and self-test features. The result codes are indeed more comprehensive than the standard Hayes set, and permit rather extensive call-progress monitoring and reporting.

The self-test feature is listed in the table of contents, so I should have found that easily. But there is no reference to the result codes, which are described in the section on commands. In either case, an index would help in finding needed information more quickly and reliably. A table of contents is not alphabetically organized and is not a substitute for a detailed index.

—Augie Hansen

BAD TRACKS

Thanks for a favorable review of our QIC-FILE tape backup subsystem in "Moving up to Tape" (Steven Armbrust and Ted Forgeron, November 1985, p. 62). We wish to clarify two points.

First, the QIC-FILE does identify bad tracks prior to restoration, allowing users to restore image data to a different hard disk than was backed up. This is extremely important for data security and all of Sysgen's backup products have always had this capability.

Second, since September 1985, Sysgen has been shipping a major enhancement to the QIC-FILE: Smart software, with automatic backup. Users can set our backup subsystems much like they would a VCR. The subsystems will then automatically back up the computer's data at predetermined times.

Richard Tam
President
Sysgen, Inc.

Mr. Tam brings up a good point. Not all tape software detects bad track information on the target disk during an image restore. Most assume that bad tracks are in the same physical location on the target disk as they were on the source. This is definitely an invalid assumption if a head crash has rendered your backed-up disk unusable and the replacement drive has bad tracks in different locations.

—Ted Forgeron

SAFE SHIPPING

In "Safe Landing for Hard Disks" (December 1985, p. 147), Murray Lesser describes a program that lands the fixed disk head on an unused cylinder. Writing such a program is more than is necessary because, as the author notes, the DOS diagnostics diskette has a "Prepare System for Relocation" routine.

Rather than booting diagnostics at the end of each session, some months ago I looked at its directory listing and guessed that the file SHIPDISK.COM was the program that parked the disk head on an unused cylinder. So I copied it to the root directory, renaming it PARK.COM, which enables me to quickly "park" my fixed disk head without having the write another program.

Craig Banning
Big Pine Key, FL

Murray Lesser and *PC Tech Journal* could have saved themselves the trouble of preparing "Safe Landing for Hard Disks" by realizing that the IBM diagnostics program SHIPDISK.COM can be copied to the hard disk and used without "continually rebooting the diagnostic diskette," as the author assumes.

SHIPDISK.COM does exactly what Mr. Lesser's program does and automatically does the safe landing on all hard disks in the system if you have more than one hard drive. In addition, the program works fine with my third party 20MB Microscience drives.

Nicholas M. Baran
San Francisco, CA

LANDER will "park" both hard disks, if two are installed. I do not recommend running SHIPDISK.COM as a stand-alone program. At best, it will end in never-never land with all interrupts disabled. If you change your mind and decide you really did not want to shut down, you will have to go through the power off/power on cycle to get your system up and running again.

At worst, the results may be unpredictable. SHIPDISK uses INT 82 (one of the "BASIC reserved" interrupts) to get back to the main diagnostic program. The vector is set by the diagnostic initializer. If SHIPDISK is run stand-alone and any previous program set that vector, almost anything could happen. Thus, if you never have gotten into trouble running SHIPDISK stand-alone, you have been lucky.

—Murray Lesser

A CHASM OVER CHASM

I was pleased to see my user-supported assembler CHASM included in your recent review of assemblers for the IBM PC ("PASM, TASM, and CHASM," Ted Mirecki, December 1985, p. 161). However, I was very disappointed in Mr. Mirecki's cursory treatment of the package. Although what little factual data presented about the program was quite correct, I feel that the author has somehow missed the whole point behind CHASM's design.

Mr. Mirecki's negative review seems to have developed primarily from the fact that CHASM does not implement the syntax of the IBM Macro Assembler. The review implies that CHASM's syntax was generated more or less at random, blindly disregarding existing standards. But as is quite clearly indicated in CHASM's documentation, CHASM was purposely designed with a simpler syntax and pseudo-op set that is more suitable for beginning assembly language programmers.

I feel that faulting CHASM for not slavishly following the complexities of MASM is equivalent to dismissing a BASIC compiler because it did not accept FORTRAN source code. In design, BASIC is a beginner's version of FORTRAN. While one would not choose to perform realtime image analysis in BASIC, neither would it be most efficient to learn the rudiments of programming by struggling with FORTRAN. Their close heritage aside, BASIC and FORTRAN are distinct languages. Both are useful tools, but intended for different jobs. The same can be said of CHASM and MASM.

The review does raise one interesting pedagogic issue. Mr. Mirecki has tacitly assumed that the preferred method of learning assembly language is through imitation, copying source files from magazines and assembling them. Although there is some merit in this idea, the philosophy behind CHASM is that neophytes learn best by doing, and CHASM's syntax and pseudo-op set were designed to allow beginners to be producing their own working programs as quickly as possible.

This philosophy is also reflected in the documentation notes and special features to writing small machine language routines for BASIC and external procedures for Turbo Pascal. These allow beginners to write useful, functional assembly language code, while still performing I/O and main program design in a high-level language.

Because imitation can be a useful mechanism for learning, a number of sample source files are included in the CHASM package. Although (as is mentioned in the review) these programs do perform useful tasks, their primary function is to demonstrate various assembly language techniques and good program organization. CHASM's documentation is also liberally filled with coding examples.

More than 40 colleges and universities are currently using CHASM in introductory assembly language courses. While CHASM's low price undoubtedly contributed to their decision to use the package, most have indicated that CHASM's accessibility to beginners was a major factor in their choice. Once students have learned the basic concepts of assembly language with CHASM, they are easily able to master the syntax of any assembler, be it MASM or one implementing the instruction set of a totally different processor.

Despite CHASM's orientation towards simplicity for beginners, a sig-

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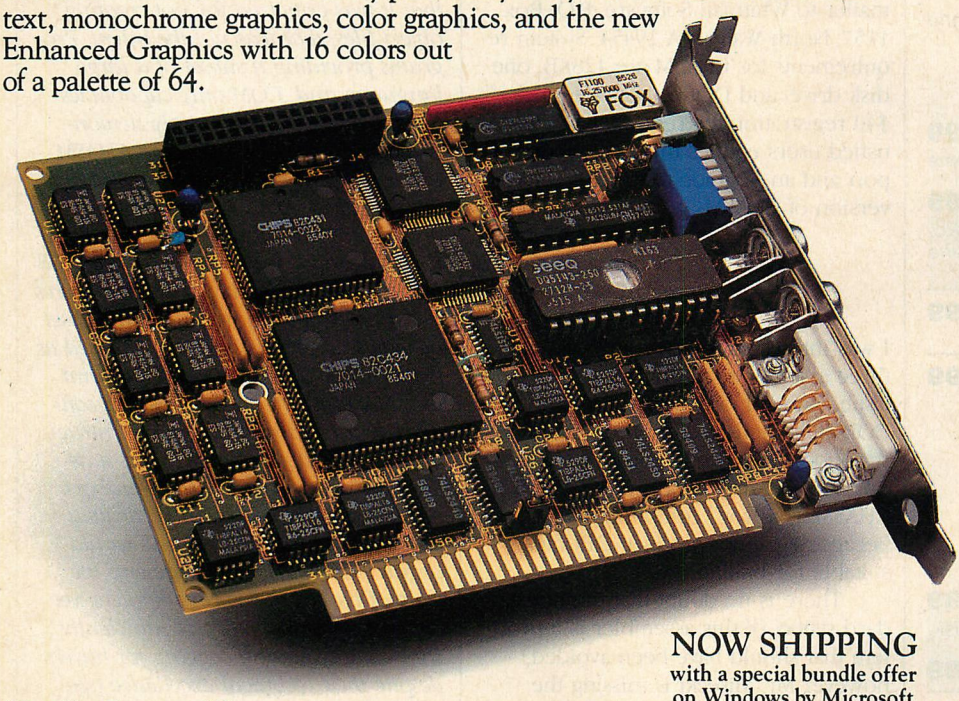
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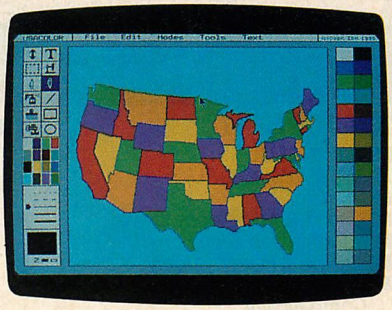
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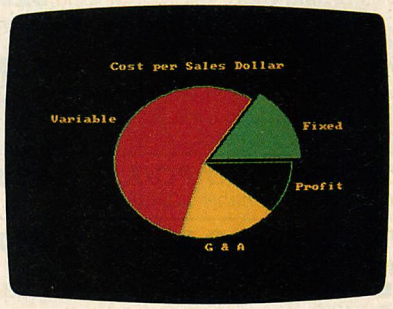
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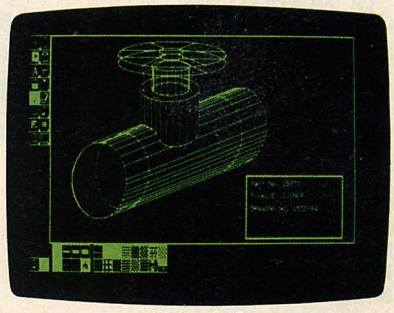
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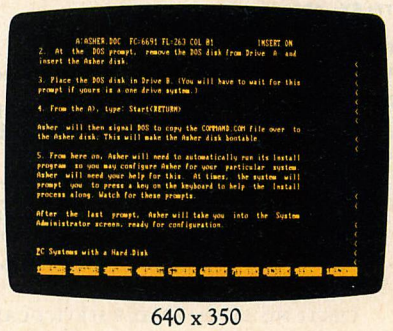
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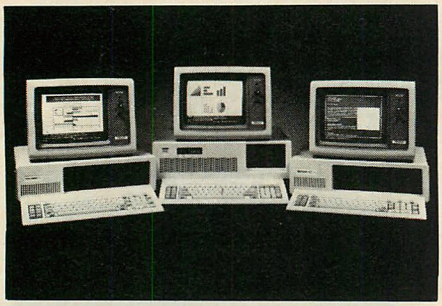


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nificant number of CHASM "graduates" find they never need the added power, complexity, and expense of MASM. Through phone support, we know of CHASM users writing text editors, an implementation of FORTH, custom device drivers, game software, and various DOS filters and utilities. With the addition of 8087 support in CHASM 4.02, other users are writing floating-point routines for BASIC and exploring fractals and the Mandelbrot set.

Unlike any of the other products reviewed, readers can evaluate CHASM and make their own judgment prior to making a purchase. Those users who are interested are invited to send a formatted diskette and a stamped return mailer to Whitman Software, P.O. Box 1157, North Wales, PA 19454. System requirements for CHASM are 128KB, one disk drive, and DOS 2.0 or later. The $40 registration fee requested from satisfied users entitles them to phone support and an upgrade to the full macro version of CHASM.

David Whitman
Whitman Software
North Wales, PA

I was interested to see your review of three assemblers in the December issue. (Indeed, one more article on COBOL compilers and I'll drop my subscription.) However, I must take exception to Ted Mirecki's dismissal of CHASM as a "toy" compiler, merely because it cannot product .OBJ files suitable for linking.

There is no doubt that the nonstandard syntax of this assembler is a problem that should have been avoided, however Mr. Mirecki is missing the point. Many people—especially beginners—are writing small assembly language programs that will end up as .COM files anyway. CHASM provides a greatly simplified method for quickly and efficiently producing programs, without the excessive declarations that are required by MASM and the other "big league" products.

Avoiding the extra steps required by LINK and EXE2BIN is a feature, not a bug. I am convinced that much of Turbo Pascal's enormous success is due to exactly this same reason. It can quickly turn out .COM programs that are immediately usable with only a minimum of bother and complication.

Most of the assembler routines that I develop are intended to be called from BASIC, so CHASM is actually better for my purposes. It probably would make more sense to compare CHASM to the assembler included in DEBUG, which does not allow the use of labels.

My only real disappointment with CHASM has been that, because it does not recognize the DIV instruction, it forces the use of DB instead.

Ethan Winer
Software Support Systems
East Norwalk, CT

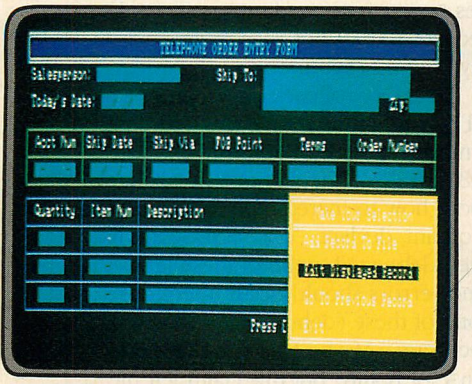
I seem to have hit a nerve out there. User-supported software often engenders the strongest user response; it seems the loyalty of users to a program is in inverse proportion to its price.

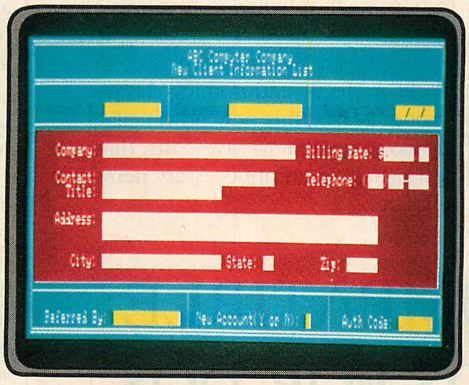
I am sorry if the review gave the impression that CHASM was being compared feature for feature with MASM, or that it was criticized for not creating object files; that was not the intent. Programs providing a subset of a large language and .COM-only capabilities have their place (as is amply demonstrated by Turbo Pascal), and CHASM was evaluated on its merits within that classification. As I tried to point out, the greatest failing I found in CHASM was not that it did not measure up to a full-featured assembler, but that the features it did provide were not a proper subset of the assembler universally accepted as standard. It is totally beside the point that MASM is not the best possible software incarnation of the 8088 instruction set; the fact is that MASM is a de facto standard that program authors ignore at their own peril. To draw a parallel in hardware, no one would argue that the IBM PC represents the state of the art in microcomputers, yet better systems that are not sufficiently IBM compatible are begging for buyers despite their technical excellence (see Apple, Texas Instruments, AT&T, etc.).

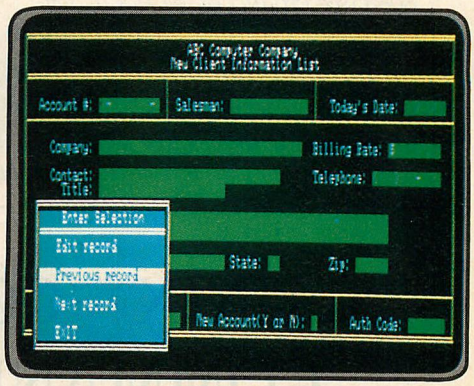
Calling CHASM a "toy" was not meant to be pejorative. In academic circles, the simplified assemblers and compilers that students use and write are commonly called that, with no reflection on their educational value. There is no question that a user new to assembly language will pick up CHASM much more readily than MASM: most simple programs are easier to learn than powerful ones (compare PC-File, another user-supported program, to dBASE). But just as the instruction set makes a microprocessor, pseudo-ops make an assembler. Although CHASM can teach the instruction set, it falls short in teaching the techniques that can really make an assembler jump through the hoops.

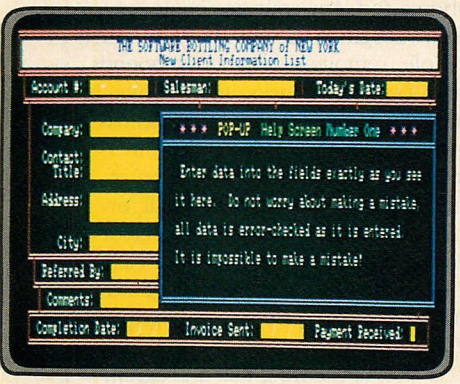
The assembler review was written from the perspective of the professional

Flashy Programs.

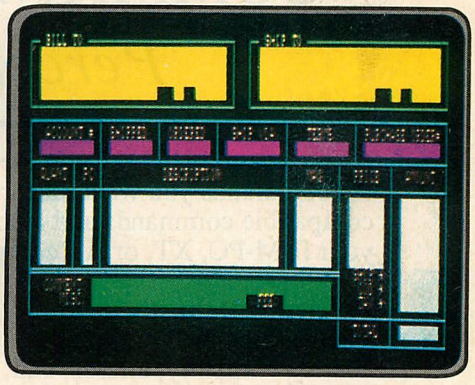












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programmer, rather than the student. Perhaps CHASM is out of its depth on that basis, but even as an educational tool, it falls short of some others of that type: the base version of TASM at about the same price, or The Visible Computer: 8088 (see Product of the Month, Jeff Duntemann, September 1985, p. 25) at just a little more. With no offense intended to CHASM's many fans, I stand by its overall evaluation and ranking in comparison to the other products.

—Ted Mirecki

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Allegory rollback: "A Slimmer Pascal" (Programming Practices, Steven Armbrust and Ted Forgeron, October 1985, p. 173). The authors, in talking about how to increase performance in a program, declare, "once a program has been debugged, none of these (runtime) errors should occur, therefore none of these (debugging) features is necessary." Maybe I have a distorted sense of reality, but this claim left me flabbergasted. Any software engineer should recognize the absurdity of it. In principle, removing safeguards, bounds checks, overflow checks, and the like, is potentially just as serious as the scenario with the nuclear power plant. In practice, of course, the expectation of remaining error can be very small, or the possible effects of remaining error could be minimal. Thus, I do not claim that every possible software safeguard should always be used. My only gripe is with the authors' statement that I mentioned above, claiming that a program can ever actually be *completely* debugged and error free.

Mike Sorens
Qcad Systems, Inc.
San Jose, CA

Mr. Sorens is correct. It is absurd to think that a program ever can be completely debugged and error free. Our intent in the article was to document how to increase program performance for applications in which relaxing runtime error checking would not yield fatal results. We hope that such optimizations are used with discretion and never applied to nuclear power plant software.

—Ted Forgeron

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I would like to thank you for your outstanding series of reviews of database management systems. It is very difficult to evaluate such sophisticated products from the sketchy advertising literature the publishers provide. And it is also usually difficult to get a good demo of a product in a retail store. Therefore, magazine reviews of hardware and software products are a very important source of information when making a decision of which product to buy.

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Commands.

grep,fgrep - search files for patterns
diff - compare files, print differences
ls,ll,lr - sorted directory listing
pr - format files for printing
mv - move files or directories
cp - copy files or directories
cat - type or concatenate files
rm - remove files or directory trees
head - print first few lines of files
tail - print last few lines of files
tee - copy piped data into a file
wc - count words and lines in files
mkdir, rmdir - make, remove directories
touch - update time of a file
pwd - print working directory
chmod - change file mode (attributes)
split - split up a big file
df - print disk free space
cu - communicate with another system
encode, decode - cu binary files

Shell Internal Commands

sh - command interpreter
cd - change dir, default to $HOME
history - print history of commands
! - re-execute a previous command
alias - establish a command macro
unalias - remove a command macro
dirs, pushd, popd - directory stack
set - set environment variables
which - find executable command

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CIRCLE NO. 178 ON READER SERVICE CARD

Your comprehensive series of in-depth articles sets the standard for what a product review should be. From these articles I was able to get a good feel for the capability and "personality" of each program reviewed so far. Well-written, well-researched articles such as these are second only to a hands-on demonstration in terms of acquainting a potential user with a software product.

David L. Salahi
Irvine, CA

TIMELY, BUT COSTLY

This letter concerns Thomas V. Hoffmann's response to Ray Smith in the October 1985 issue (Letters, p. 15), in which he says that, "IBM is late (in making ... advanced materials available to advanced users.)" I called my "local" IBM Product Center (110 miles away) asking for the technical reference manual for the EGA. I *immediately* was sent the two-volume set, which included a card saying I would have to send for an update. I called the product center to explain that I was in a hurry, and was told to write urgent on the card. I did write urgent in big red letters and, unbelievably, received the update with the ROM BIOS listing for the EGA in about 10 days! Great service, I think.

The $125, however, is a bit steep. I feel that while IBM may not be so late, I do criticize the company for the format. For that $125 I should get a videotape and a how-to book full of examples, not just a hard-to-read listing.

R. L. McGhee
Lynchburg, VA

CONSCIENTIOUS PROGRAMMERS

I am writing in response to "Livin' in the D.O.S." (Directions, Will Fastie, December 1985, p. 9).

As I happened to be writing a video mode and display interrogation module for my Turbo Pascal programs when I read Mr. Fastie's column, I would like him to know that some of us out here have enough pride in the software that we write to provide just such interfaces as he describes.

The one I was writing handles all the cards in question, obtains and stores the user's previous video mode, interrogates the hardware to find out what modes the display can be driven in, sets the display into the highest resolution mode available or at least whatever mode is needed, and finally, it restores the machine to whatever prior mode it was in before it ends.

One small problem with this is that there is no way to tell whether or not a user has a monochrome composite monitor connected to the video output of the IBM CGA. For that reason, the CGA default must be black and white.

Michael E. Piazza
Concept Arts
New York, NY

No offense was meant to anyone who has implemented a "clean livin'" system. My point was that such good programs are in woefully short supply.

—WF

AND IT ERASES

I implemented Victor Mansfield's line-drawing routine ("Scientific Graphics with the EGA," Programming Practices, September 1985, p. 163) in Turbo Pascal on a Tandy 2000 machine. The only required changes are that of the segment address of the graphics page, which is $E000 in the Tandy, and expanding the **yaddr** array limits to correspond to the Tandy's 640-by-400 resolution. I also changed the declaration of **point**, the bit offset for a given *x*-coordi-

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CIRCLE NO. 160 ON READER SERVICE CARD

nate, from INTEGER to BYTE to reduce the amount of bit manipulation.

The line drawing procedure (**draw**) that Mr. Mansfield presented differs from the one offered by Turbo Pascal, which has an additional parameter to allow the routine to draw a line (parameter = 1) or to erase a line (parameter = 0). A very simple modification of the Mansfield program can implement this capability. An additional value parameter called **show** is incorporated in the dummy parameter list of the **draw** procedure. Each of the two occurrences of the statement

```
MEM[ $A000: dtotal] := point[xx1]
  or MEM[ $A000: dtotal],
```

in the original program is replaced with the following statements:

```
if show = 1 then {normal plot}
MEM[ $A000: dtotal] := point[xx1]
  or MEM[ $A000: dtotal]
else {erase}
MEM[ $A000: dtotal] := not(point[xx1]) and
  MEM[ $A000: dtotal];
```

In the second MEM assignment, the complement of the byte point[xx1] is formed, so that all off bits are turned on and the on bit is turned off. ANDing this byte with the screen turns off the originally set bit and leaves all other screen bits unaltered. With this change, the procedure call

```
draw (x1,y1,x2,y2,1)
```

draws a line between points (x1,y1) and (x2,y2). The call

```
draw (x1,y1,x2,y2,0)
```

erases the line, just as in Turbo.

Dr. John Figueras
Victor, NY

I was delighted that Dr. Figueras was able to implement my graphics routines on the Tandy 2000. My timing tests show that a screen can be filled using the enhanced draw only 6.3 percent slower than the original; but, of course, the enhanced version also can erase.

I also want to correct a bug in procedure Screen_Dump. The statement

```
WriteLn(LST, CHR(27) + '@');
```

correctly clears the printer attributes. However, because it is inside the loop that reads the memory to the printer, this statement makes a mess of the printer output. It can be fixed by moving the statement so that it is the last line in the procedure.

—Victor Mansfield

COVER STORY

The photograph used for my review of *Microcomputer Graphics Using Pascal for the IBM PC and Compatibles* (Book Reviews, January 1986, p. 195) was of the version of the book for the Apple II, not the IBM PC. This is ironic because my last paragraph says, "The title of this book is misleading. The graphics concepts presented are not directed specifically toward use with IBM PCs or compatibles." My original draft stated that the examples used worked fine under Apple Pascal. I hope Mr. Halpern has a sense of humor.

Ray Quay
Arlington, TX

ERRATA

To correct the first paragraph of "Storage for the AT" (Thomas V. Hoffmann, February 1986, p. 147), the IBM 239 AT offers a new *system* board.

Information for Heuristic Computer Systems in "In the ISPF Tradition" (Rudy S. Spraycar, March 1986, p. 113) should read 853 Hickory Drive, Carmel, IN 46032, 317/848-8981.

PC Tech Journal regrets these errors.

—WF

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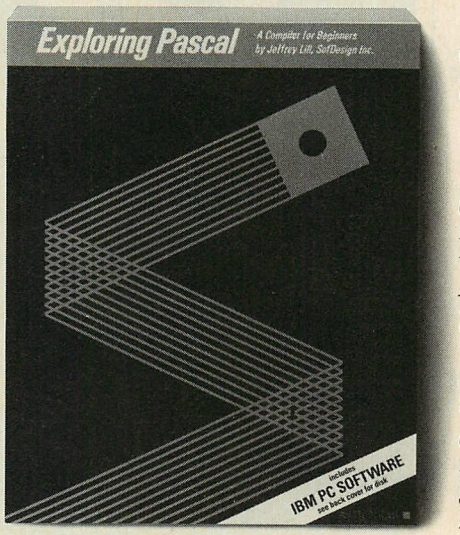
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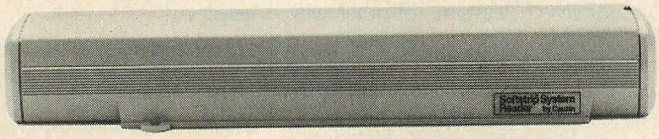
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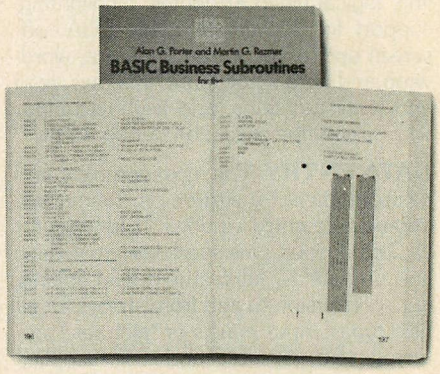
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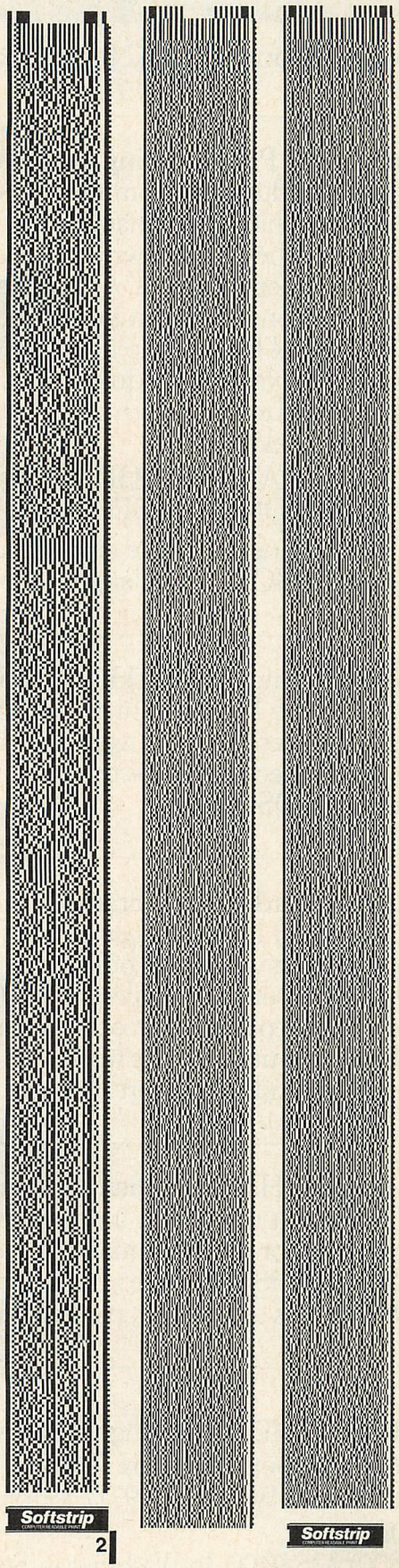
The data strip on the far right contains a utility program named **CPUID**, which stands for Central Processing Unit I.D. After you read in the data strip, simply type CPUID and the program will run. It will list the type of CPU you have and report if, in fact, your unit is healthy or not.

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```
DIM TRANSFORM3D(3,3) 'static array passed in COMMON
COMMON/GRAF3D/CURX, CURY, CURZ, TRANSFORM3D( )
```

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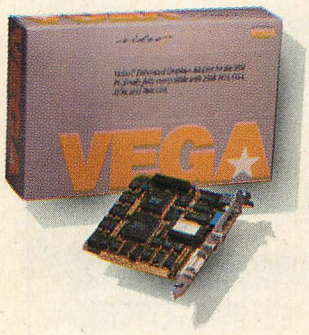
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JEFF DUNTEMANN



The VEGA Board

This cover-all-bases video adapter board handles all four PC display standards and occupies only a short slot inside the system.

Computer standards and technological advances move in a slow lockstep, with hands about each other's throats—if either becomes too strong the other suffers. IBM's Color Graphics Adapter (CGA) set a standard in 1981 that still hinders graphics software development for the PC line. The Hercules Graphics Board has become a standard of its own for monochrome graphics. Most users have despaired of good graphics altogether and continue to use IBM's Monochrome Display Adapter (MDA), the reigning text display standard. IBM has introduced the Enhanced Graphics Adapter (EGA), which is vastly better than the CGA and is quickly growing into a new standard for quality color graphics.

In advancing beyond the CGA, standards have suffered. Some software packages support the CGA and the Hercules, some only the CGA, a few only the Hercules. Some newer packages run only on the EGA, or perhaps the EGA and the Hercules. Having settled on one video adapter, users run the risk of discovering that a graphics package they badly need will not run on the board they have chosen.

A cover-all-bases display adapter that handles all four recognized PC display standards may seem too good to be true—but it exists, and, what is more, it occupies a PC short slot and costs nearly $400 less than an IBM EGA with 256KB of RAM. For these reasons, Video 7, Inc.'s VEGA Board has been named *PC Tech Journal's* Product of the Month for April 1986.

The VEGA is a remarkable technological *tour de force*. Its genesis lies with Chips & Technologies, which developed a set of four custom VLSI devices that permit full emulation of all three IBM display adapters in 32 chips, including 256KB of RAM. Video 7 added several custom chips to the Chips & Technologies chip set to cut the final chip count down to 26. Video 7's additional hardware logic as well as some custom software allow full emulation of the Hercules monochrome display as well as the three IBM adapters.

Fitting hardware logic for four different display adapters in a short-slot card was made possible by using surface-mount technology for all but 4 of the 26 ICs. Consumer-oriented plastic leadless chip carriers (PLCCs) are available in quantity and are denser than the 15-year-old DIP standard packages. The largest IC, with all of 84 pins, occupies as much space as three 16-pin DIP ICs, but replaces literally dozens. In addition, 256KB of RAM on PLCCs occupies about as much board space as a single 40-pin DIP. PLCCs cannot be wave soldered (they require vapor soldering), and each IC package must be positioned so accurately as to require mechanical placement. However, board yields and board reliability are notably higher using surface-mount technology.

PRODUCT
The VEGA Board

COMPANY
Video 7, Inc.

ADDRESS
550 Sycamore Drive
Milpitas, CA 95035

TELEPHONE
408/943-0101

PRICE
$595

The VEGA can be configured via DIP switches to boot up as an EGA, a CGA, or an MDA. Emulation of the CGA is not absolute until a resident utility is loaded. This utility captures hardware calls by ill-behaved graphics applications that do not work through ROM BIOS and interprets them correctly, regardless of the absence of a 6845 graphics controller in the system. The only graphics programs found not to work on the VEGA were ill-behaved, boot-only games that did not allow the loading of the resident emulator. Hercules emulation is not a boot-time option but a separate mode that must be initiated by way of a mode-setting transient program.

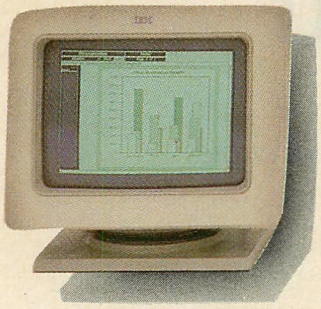
Any RGB or TTL monitor that works with any IBM display adapter can be connected to the VEGA. RCA-type jacks exist on the board bracket, but composite video output is not generated by the current release. A daughterboard connector has been built onto the VEGA, and Video 7 is working on options to provide composite video and other more exotic modes.

Although the overall quality of the board is high, three jumpers and a small pigtail capacitor have been added. (All other bypass caps were leadless chip-type caps.) Perhaps future revisions of the board will incorporate the necessary jumpers into the design.

While Video 7 designed the VEGA and will sell it to volume customers, retail marketing will be handled by Quadram Corporation under the name QuadEGA Plus. The single-unit price ($595) is the same for both vendors.

In coming months, both EGA-compatible and catchall boards will be available, heating up competition and shaving the already reasonable prices of such products. Video 7 is the first to ship the product to customers, and the VEGA Board is the only one to occupy a short slot. By placing a four-display emulator on a short card, Video 7 has provided users with an opportunity to free up a large slot in the otherwise full buses of their PC/XTs. That, in addition to the product's ability to run virtually any software package that supports one or more of the four established PC display standards, will help ease the long-standing tension between graphics technology and graphics standards.

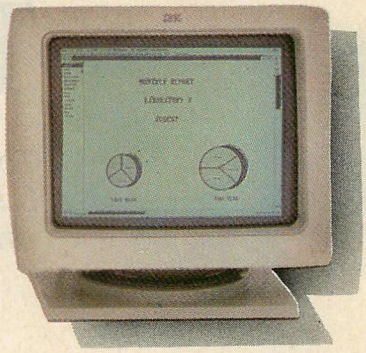
Hardware, software, and other developments for the IBM PC family.



IBM RT/PC 6153



IBM RT/PC 6154



IBM RT/PC 6155

FROM IBM

The **RT Personal Computer** line of high-speed, 32-bit workstations for technical professionals is the first to incorporate the RISC (reduced instruction set computer) architecture invented by **IBM**. The workstations can perform stand-alone CAD/CAM and CAE tasks. The units contain a new 32-bit microprocessor chip onto which RISC's simplified instructions are etched. This chip, along with a new IBM virtual memory management chip, allows the RT/PC to handle data at the high speeds required for complex applications.

The **RT/PC 6151 model 10** is a desktop version that features 1MB of real memory (expandable to 3MB), 40MB fixed-disk capacity, and a 101-key, adjustable, tilt keyboard. **RT/PC 6150 models 20**, **25**, and **25A** are floor-standing units that fit under a desk. Model 20 has 1MB of real memory (expandable to 3MB) and 40MB of fixed-disk storage (expandable to 180MB); models 25 and 25A are equipped with 2MB of real memory (expandable to 4MB) and 70MB of fixed-disk storage (expandable to 210MB). Models 20 and 25 also feature the 101-key keyboard; model 25A, however, is designed for use with a 5080 graphics system and does not include the keyboard. Model 10, $11,700; model 20, $14,945; model 25, $17,940; model 25A, $19,510.

The RT/PC runs under the new operating system called **Advanced Interactive Executive (AIX)**, which combines the multiuser, multitasking features of UNIX with ease of use and virtual memory features. As many as eight users—seven on local or remote ASCII terminals and one on an RT/PC terminal—can share an RT/PC at the same time without worrying about the size of their programs or the amount of available memory. AIX includes applications development tools and an open architecture that allows others to develop additional software and hardware applications. $3,400.

The RT/PC can be made PC-compatible with the **PC/AT coprocessor card** and **coprocessor program** that permit existing PC programs to run concurrently with RT/PC programs and to share RT/PC disk files and displays. Coprocessor card, $995; program, $550.

In addition, nine new **applications packages** are available for the RT/PC, including an integrated circuit design program and others that help engineers, scientists, and professionals develop complex drawings, process and analyze numerical data, display data graphically, and create and manipulate text, spreadsheet, and accounting data.

Other products for use with the RT/PC include three new all-points-addressable graphics displays: the 12-inch **IBM 6153 advanced monochrome graphics display** has 720 by 512 pixels; the 14-inch **IBM 6154 advanced color graphics display** has 720 by 512 pixels and can display 16 colors simultaneously; the 15-inch **IBM 6155 extended monochrome graphics display** has 1,024 by 768 pixels. In addition, the **IBM 6157 streaming tape drive**, a backup storage device that saves, transfers, and restores information, is available for the RT/PC as well as the System/36. The 6157 stores up to 55MB of data on a one-fourth-inch tape at data rates up to 5MB per minute. An eight-pen plotter, the **6180 color plotter**, produces high-resolution engineering drawings, graphs, charts, and diagrams on standard transparencies and paper. 6153, $610; 6154, $1,550; 6155, $1,150; 6157, $1,795; 6180, $1,285.



IBM RT/PC 5080 Graphics System

New products available for both the RT/PC and the 5080 graphics system include the **IBM 5083 tablet**, which permits CAD/CAM designs to be modified quickly with precise movement of the screen cursor in any direction, and a lighted program-function **32-key keyboard**. Keys that are operable during program sessions light up. 5083 tablet, $575; 32-key keyboard, $550.

IBM Corporation, Information Systems Group, Rye Brook, NY 10573; Contact the local IBM dealer, 800/426-2468

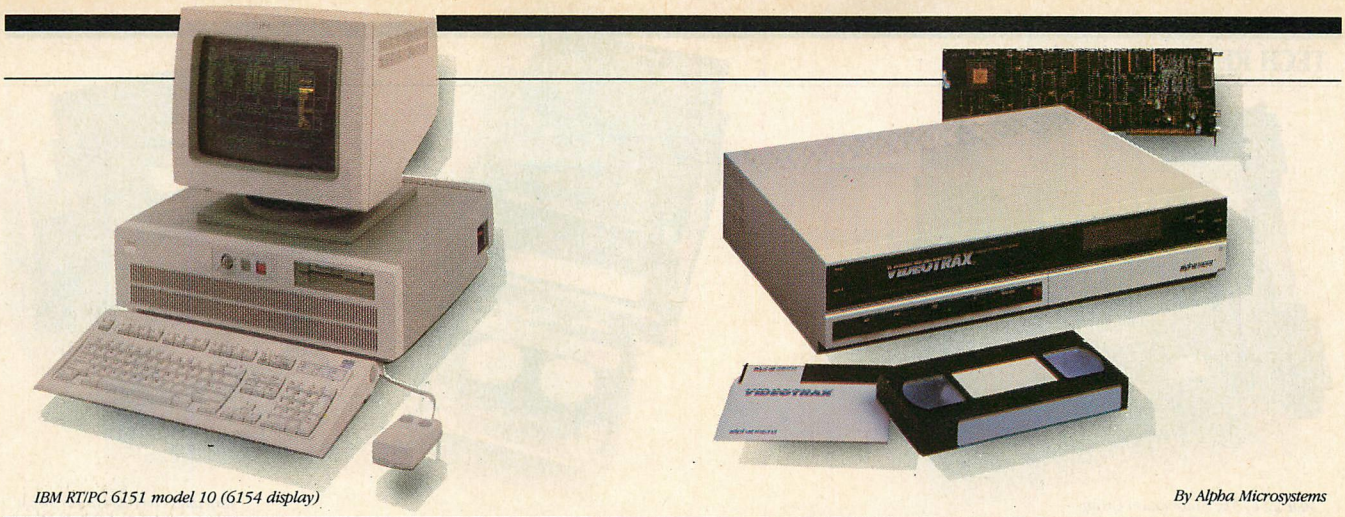
CIRCLE 306 ON READER SERVICE CARD

HARDWARE

OmniTel, Inc. has announced three new products. A single-board, half-size 2400-bps internal modem, the **2400HB** is V22 bis and Bell 212A/103 compatible. It fits into the half-size slot of the XT, Portable PC, or compatible, and is designed to operate on the switched telephone network in full duplex at 300 bps, 1200 bps, or 2400 bps asynchronously. The **1200HB** is a single-board, half-size 1200-bps modem also designed for the half-size slot. The 1200HB uses the industry-standard AT command set and is compatible with the Hayes 1200B full-size internal modem. It comes packaged with RELAY software, which enables a PC to act as a communicating workstation. **OMNIPAK** is a single-board multifunction card with a built-in modem that uses one expansion slot. It features 384KB of memory, parallel/serial ports, a game port, and a clock/calendar with battery backup. OMNIPAK is upgradable to 2400 bps. 2400HB, $695; 1200HB, $399; OMNIPAK, $599.

OmniTel, 3090 Oakmead Village Drive, Santa Clara, CA 95051; 408/986-8236

CIRCLE 314 ON READER SERVICE CARD



IBM RT/PC 6151 model 10 (6154 display)

By Alpha Microsystems

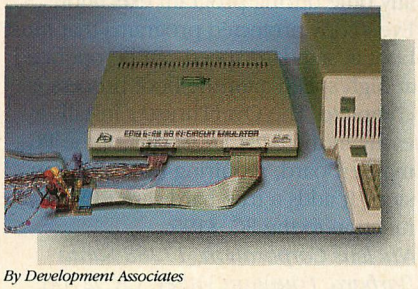
The **Archival Storage Protector (ASP)** from **Emerald Systems Corporation** is a Novell-compatible backup utility that offers full support for Novell LANs, including Netware special files. ASP is available only with Emerald's one-fourth-inch tape backup subsystems for both stand-alone and networked IBM compatible microcomputers. It is menu driven with a light bar that moves across the PC's display screen, illustrating the percentage of the hard disk that has been safely backed up. ASP can handle multiple session backups, permitting users to do more than one backup with the same tape cartridge. Internal version, $1,770; external version, $2,130.
Emerald Systems Corporation, 4757 Morena Blvd., San Diego, CA 92117; 619/270-1994

CIRCLE 309 ON READER SERVICE CARD

Designed to increase the capabilities and performance of the Waterloo Port Networking Operating System, **VRAM**, a virtual RAM card, has been announced by **Waterloo Microsystems, Inc.** A Port workstation equipped with a VRAM card can run 640KB DOS applications, concurrently access network services, send mail, and perform terminal emulation. The VRAM card occupies one expansion slot and operates at speeds of up to 8 MHz. It takes full advantage of the AT's 16-bit data path. With 512KB of memory (expandable to 1MB), $695.
Waterloo Microsystems, Inc., 175 Columbia Street W, Waterloo, Ontario, Canada N2L 5Z5; 519/884-3141

CIRCLE 311 ON READER SERVICE CARD

A realtime transparent emulator for the 8048 microprocessor family has been announced by **Development Associates**. The **Model E-48/50**, weighing only 10½ pounds, provides a complete emulation facility in realtime to 11 MHz. The emulator's 8085 control processor can be programmed by the user for automatic factory test equipment applications. Provisions for as many as 4,096 selectable realtime program memory breakpoints with up to 1,023 selectable instruction cycles of 56-bit-wide trace memory allow detailed examination of execution history. The trace depth is user selectable and easily changed. The E-48/50 includes a 24-bit programmable counter that increments, selectably, on



By Development Associates

any address location(s) executed, as well as an external programmable synchronous generator that can be used as a test equipment trigger. $3,995.
Development Associates, 1520 S. Lyon Street, Santa Ana, CA 92705; 714/835-9512

CIRCLE 316 ON READER SERVICE CARD

Eliminating the need for NTSC composite color decoders and their inherent quality limitations, the **CA-1700 RGB Camera** from **Chorus Data Systems, Inc.** includes a macro-zoom lens, auto-iris, and selectable RS-170 black and white or NTSC color with simultaneous RGB output. This compact, lightweight camera is supported by Chorus's 4-, 6-, and 8-bit per pixel PC-EYE video digitizers. The company's **IMiGIT PLUS** software provides complete true-color image capture as well as cut/paste, annotation, and editing capabilities. CA-1700 RGB Camera, $1,295; PC-EYE video digitizers, $495-$1,495; IMiGIT, $695.
Chorus Data Systems, Inc., 6 Continental Blvd., P.O. Box 370, Merrimack, NH 03054; 800/OCHORUS; 603/424-2900

CIRCLE 310 ON READER SERVICE CARD

From **Alpha Microsystems** comes the **Videotrax** backup subsystem for the PC, PC/XT, and PC/AT, which provides 80MB of interactive, reliable hard-disk backup using videotape and VCR technology. Mounted on the PC's full-sized expansion slot, a circuit board converts data into a video format (and vice versa) that any standard VHS or beta recorder can read. Subsystem (controller board, software, and computer-controlled videotape drive), $1,595; controller board and software alone, $795.
Alpha Microsystems, 3501 Sunflower, P.O. Box 25059, Santa Ana, CA 92799; 714/957-8500

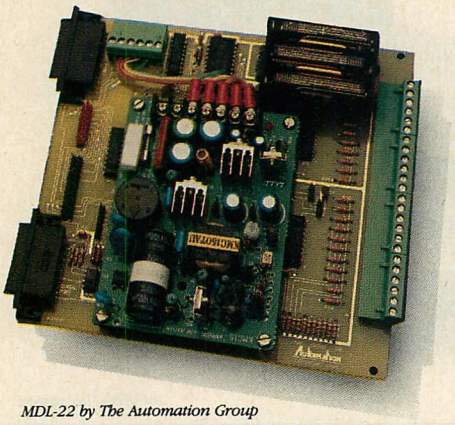
CIRCLE 307 ON READER SERVICE CARD

Hayes Microcomputer Products, Inc. has introduced the **Smartmodem 2400B**, an internal modem for the PC/XT, PC/AT, or compatible. It operates at 2400 bps, 1200 bps, or 0 to 300 bps over standard dial-up or leased lines, and supports both asynchronous and synchronous data transmission through a standard PC communications port. $739; with Smartcom II, $799.

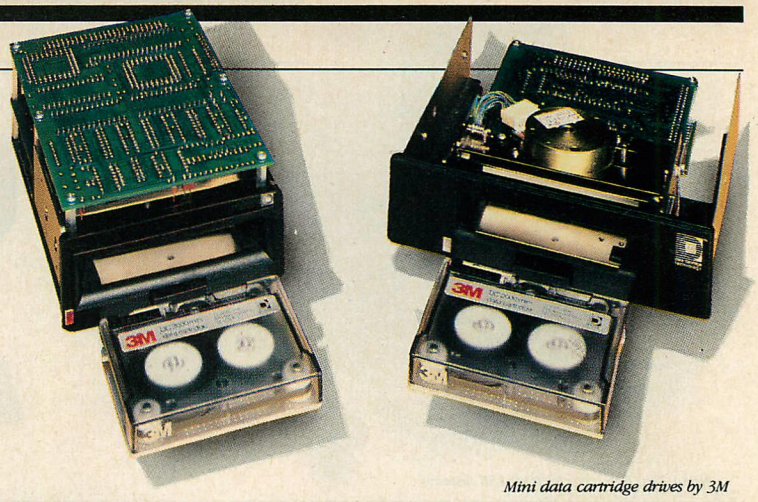
Also from Hayes is the **Hayes Synchronous Driver (HSD)** with support routines for Hayes communications products. HSD provides complete HSI support for the Smartmodem 2400 and the Smartmodem 2400B. It can be licensed from the company by software developers on an annual basis. $100.

In addition, Hayes announced that it is making public a synchronous application interface definition, called the **Hayes Synchronous Interface (HSI)**. This set of conventions aids software developers in designing software so that synchronous communications applications are isolated from the differences between various hardware implementations. Free of charge.
Hayes Microcomputer Products, Inc., P.O. Box 105203, Atlanta, GA 30348; 404/441-1617; 404/449-8791

CIRCLE 322 ON READER SERVICE CARD



MDL-22 by The Automation Group



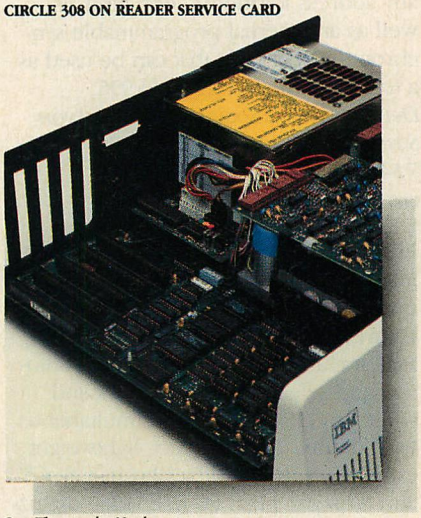
Mini data cartridge drives by 3M

The **MDL-22**, a peripheral and data acquisition device for industrial control, monitoring, and data logging has been announced by **The Automation Group, Inc.** MDL-22 has 22 8-bit analog inputs; 16 digital I/O lines (8 inputs and 8 outputs); a serial port for RS-232 or 20MA current loop communications; a parallel printer port; a realtime clock; ASCII command-driven peripheral, data acquisition system, or stand-alone data-logging operation; and an optional piggyback switching power supply and 40-column printer. $159.
The Automation Group, Inc., 848-O Nandino Blvd., Lexington, KY, 40511, 606/252-6753
CIRCLE 313 ON READER SERVICE CARD

The **DEM-1000** from **Star Gate Technologies** is a multifunction data encryption/memory module that offers an inexpensive way to provide data security. The module is ideal for electronic funds transfer, electronic banking, and data handling applications. DEM-1000 provides a hardware implementation of the DES encryption algorithm adopted by the National Bureau of Standards in 1977. It features four memory sockets that can provide up to 256KB of EPROM or a combination of EPROM, EEPROM, and CMOS static RAMS. $199.
Star Gate Technologies, P.O. Box 764, Cleveland, OH 44026; 216/951-5922
CIRCLE 317 ON READER SERVICE CARD

Using an 80286 microprocessor, the **286 SPEED PAK Accelerator** enables a PC or PC/XT to perform at speeds 33-percent faster than those possible with a PC/AT. Introduced by **Classic Technology Inc.**, the 286 SPEED PAK operates at 8 MHz with a 16-bit BIOS and data path. It offers multitasking support and can address up to 16MB of memory. $1,295.
Classic Technology Inc., 2090 Concourse Drive, San Jose, CA 95131; 408/434-9333
CIRCLE 323 ON READER SERVICE CARD

The **OverThruster** is designed to accelerate the speed of all processor operations by 60 percent. Released by **Nucleus Corporation**, this product speeds up all 8088 and 8087 operations from the standard 4.77 MHz to 7.38 MHz when in the high-speed mode. Total compatibility with all software is assured because the user can switch speeds at any time during program execution. Even copy-protected programs that must boot at standard speed can be operated at high speed after the boot process is complete. The OverThruster installs easily in the 8284 I.C. socket of the PC motherboard, requiring no expansion slots. It adds a true hardware RESET function to the PC. $195.
Nucleus Corporation, 17288 Santa Barbara, Fountain Valley, CA 92708; 714/841-3336
CIRCLE 308 ON READER SERVICE CARD



OverThruster by Nucleus

A single-slot card for the IBM PC family that delivers advanced graphics, sharp text generation, and full color capabilities by combining the features of four different display adapters has been announced by **AST Research, Inc.** The **AST-3G** is fully compatible with software written for the IBM EGA, the IBM CGA, the IBM Monochrome Display and Printer Adapter, and the Hercules graphics card. The AST-3G comes standard with a parallel printer port. Attached to the IBM 5154 enhanced color display, it can display 16 simultaneous colors from a palette of 64 in the 640-by-350 graphics mode, while providing an 8-by-14 character box for text. Under $600.
AST Research, Inc., 2121 Alton Avenue, Irvine, CA 92714; 714/863-1333
CIRCLE 312 ON READER SERVICE CARD

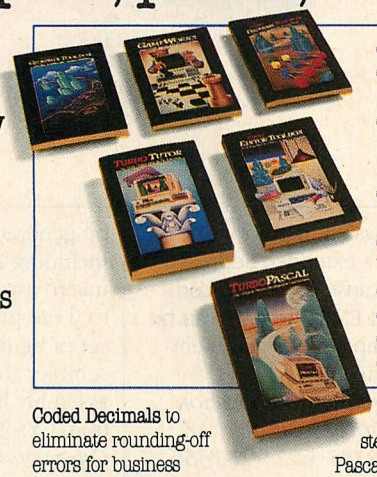
New **mini data cartridge drives** in 3½-inch and half-height 5¼-inch form factors have been announced by **3M**. The new drives and optional SCSI controller will provide PC users with 40MB of fully corrected capacity using 3M's DC2000 one-fourth-inch mini data cartridge. Both drives use the QIC-100 data format to provide reliable data interchange. They offer continuous or stop/start tape motion as well as streaming or random access operation. Less than $300 in OEM quantities.
3M, P.O. Box 33600, St. Paul, MN 55133-3600; 612/736-2355
CIRCLE 319 ON READER SERVICE CARD

Percom Data Corporation has introduced the **Expander Plus** line of mass storage and expansion products. Both the **Expander Plus Low Profile** and **Full Height** allow users to configure any two combinations of hard-disk drives, tape backup, or removable cartridge drives. The units accept four expansion boards, which are connected to the PC via Percom's unique bus expansion design. These products feature an AC surge suppressor, four AC receptacles, five front panel control switches, LED indicators, a static discharge plate, and shielded round cables that can be disconnected without taking the expansion box. $995 each.
Percom Data Corporation, 2703 National Place, Garland, TX 75041; 214/840-3032
CIRCLE 315 ON READER SERVICE CARD

Turbo Pascal® and the Turbo Pascal family give you a perfectly integrated programming environment and unbeatable speed, power, and price

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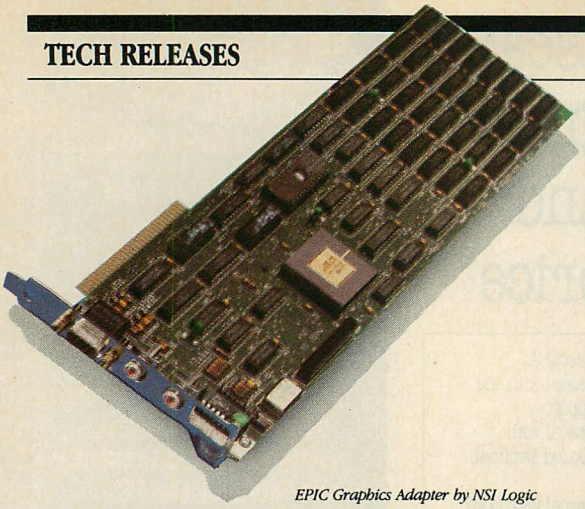
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EPIC Graphics Adapter by NSI Logic



Optimem 1000/S

Optimem's 1000/S is a high-performance, high-capacity optical disk drive subsystem based on a 12-inch, 1-billion-byte optical disk drive. This write-once subsystem is designed for permanent, on-line, high-capacity archival storage in PC-based CAD/CAE systems, as well as in computer graphics, publishing, medical records management, legal, and other professional applications. An installable device driver, along with the software needed for large-scale file management, enables the user to write DOS-compatible files to then manage on the Optimem 1001 optical disk, which is the equivalent of 50 standard 20MB AT hard-disk drives. $20,000.
Optimem, 435 Oakmead Parkway, Sunnyvale, CA 94086; 408/737-7373
CIRCLE 318 ON READER SERVICE CARD

Tecmar, Inc. introduced **MegaFunction**, an add-on board for the PC that combines multifunction capabilities with the speed of a 1.25MB RAM disk. MegaFunction's nonvolatile RAM disk has an independent power supply. It eliminates the time necessary to access hard or floppy disks but does not drain system memory. The package includes 1.25MB of memory, a RAM disk with an auxiliary power supply, a parallel printer port, a serial port, and a clock/calendar. Onboard ROM allows users to boot systems quickly from the RAM disk. $895.
Tecmar, Inc., 6225 Cochran Road, Solon (Cleveland), OH 44139-3377; 216/349-0600
CIRCLE 324 ON READER SERVICE CARD

FASTCARD is a high-density expansion board that allows 1MB of memory per square inch of board space. Introduced by **THESYS Memory Products Corporation**, it provides error-detection capabilities of four bit errors per 16-bit word and error-correction capabilities of two errors per word. **FASTCARD PLUS** provides 8MB of memory on a single board, and 16MB with two boards. This memory can fill system memory to 640KB and an AT's extended address space as well. Because the board complies with the LIM EMS, the RAM can be used as Lotus-compatible paged memory. Prices not available.
THESYS Memory Products Corporation, 7345 E. Acoma Drive, Scottsdale, AZ 85260; 800/327-8345; 602/991-7356
CIRCLE 321 ON READER SERVICE CARD

The three-in-one EGA-compatible **EPIC Graphics Adapter** offers high-definition text and graphics in as many as 16 colors simultaneously from a palette of 64. In its three distinct modes, the EPIC, produced by **NSI Logic, Inc.**, emulates the EGA, the CGA, and the MDA adapters at both the BIOS and hardware level. The modes can be switched through either a software or hardware switch, and the adapter remains in the selected mode even after a warm boot. The EPIC Adapter uses the Enhanced Video Graphics Controller (EVC) chip, which features display memory control, DRAM refresh control, video refresh control, controls for video screen scrolling and panning using a display memory larger than the screen, a color palette section, and an array of fully programmable registers. $595.
NSI Logic Inc., Cedar Hill Business Park, 257-B Cedar Hill Road, Marlboro, MA 01752; 617/460-0717
CIRCLE 325 ON READER SERVICE CARD

SOFTWARE

Development of Texas Instruments 320 series digital signal processor code now is supported on the PC with the help of the **CYS-320 Cross Assembler** from **Cybernetic Micro Systems**. The CYS-320 software package contains a symbolic assembler that accepts standard T. I. mnemonics as source code input and generates a listing and an Intel format hex file as output. Source programs can be generated from standard editors, including EDLIN and WordStar. The macro assembly feature allows the user to write programs using a meaningful set of higher level functions; the assembler then generates the step-by-step assembly language code for each function. CYS-320 package, $295.
Cybernetic Micro Systems, P.O. Box 3000, San Gregorio, CA 94074; 415/726-3000
CIRCLE 333 ON READER SERVICE CARD

The Engineering and Scientific Products Division of **Lotus Development Corporation** has announced the sale of **TK!Solver** to **Universal Technical Systems**. TK!Solver is an equation-solving program for engineers, scientists, and other professionals. $200.
Universal Technical Systems, 1220 Rock Street, Rockford, IL 61101; 815/963-2220
CIRCLE 326 ON READER SERVICE CARD
Lotus Development Corp., 55 Cambridge Parkway, Cambridge, MA 02142; 617/577-8500
CIRCLE 327 ON READER SERVICE CARD

Introduced by **Concentric Data Systems, Inc.**, **dB Report Writer** analyzes any dBASE II or dBASE III file and displays a starting report format tailored to the user's printer page size, allowing up to 250 printer columns by 112 lines. The user then arranges the report visually in columnar, row, page-per-record, or mailing label format. dB Report Writer features English-like query with AND, OR, and full selection rules. It allows up to four sort levels, plus subtotaling options for counts, sums, averages, and minimum/maximum. Report definitions can be saved for later use, and reports can be run in batches without user intervention. $125.
Concentric Data Systems, Inc., 18 Lyman Street, P.O. Box 4063, Westboro, MA 01581-4063; 617/366-1122
CIRCLE 329 ON READER SERVICE CARD

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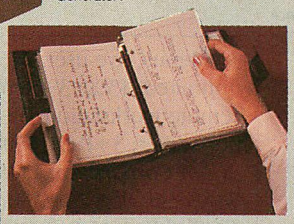
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More than half a million of you already know how indispensable SideKick, the RAM-resident desktop manager, is on your IBM® PC (So do many Macintosh™ owners who are now using our SideKick/Mac version). While SideKick enjoys the rank of #1 best seller for the IBM PC, it can only go where your computer goes—so if your computer stays in your office or den, so does SideKick. Traveling SideKick changes all that.

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Until September 1, 1986, you can get Traveling SideKick for just $69.95—which is tremendous short-term and long-term value. Short-term because it solves immediate problems at a very low price, and long-term because Traveling SideKick works this year, next year, and all the "next years" after that. (Unlike old-fashioned daytime organizers, electronic organizers and calendars aren't obsolete at the end of the year.)

What's inside your Traveling Sidekick



TABLET OF EXTRA FORMS
IN POCKET ON BACK FLAP. FOR USE IN ANY OF THE ORGANIZER SECTIONS.

ADDRESS BOOK SECTION
PREPRINTED ADDRESS FORMS WITH TABBED DIVIDERS FOR EASY REFERENCE.

MISCELLANEOUS SECTION
TO STORE ALL EXTRA PREPRINTED FORMS AND COMMONLY-USED RECORDS.

ROLLER BALLPOINT PEN
BLACK PEN THAT FITS IN FLAP FOR EASY ACCESS.

REFERENCE SECTION
CONTAINS MAPS THAT SHOW AREA CODES AND TIME ZONES, TOLL-FREE NUMBERS FOR TRAVEL ACCOMODATIONS, METRIC CONVERSION CHARTS.

FINANCE SECTION
MULTI-USE LEDGER FORMS, RECEIPT LOG AND STORAGE ENVELOPE. CREDIT CARD INFORMATION.

CALENDAR SECTION
YEARLY, MONTHLY, WEEKLY, AND DAILY ENGAGEMENT CALENDARS SUPPLEMENT THOSE YOU PRINT OUT WITH TRAVELING SIDEKICK.

PENDING SECTION
A "TO BE CONTINUED" SECTION FOR CURRENT PROJECTS, MEETING NOTES, ETC.

CALCULATOR
IN ONE OF TWO BUSINESS-CARD-SIZE STORAGE POCKETS.

TRAVELING SIDEKICK SOFTWARE
GENERATES, UPDATES, AND PRINTS YOUR ADDRESS AND CALENDAR FILES.

Special Offer: Get both SideKick and Traveling SideKick for only $125.00

You probably already have SideKick, but in case you don't, we're offering you *both* SideKick and Traveling SideKick for only $125.00. (SideKick alone is usually $84.95. Add that to Traveling SideKick's $69.95, and you're looking at $154.90—which you don't have to look at, because you get $29.90 off when you buy both.) Whichever way you buy, you're getting our 60-day money-back guarantee** and making a highly organized and productive step into modern business life.

Traveling SideKick is an organizer, a binder, a software program and a report generator that picks your SideKick's brain, then prints out your appointments, daily, weekly, monthly, or yearly calendar, your phone lists, and mailing labels, itinerary, or whatever else you need.

YES! I want the best.

Rush me Traveling SideKick at:

$69.95*

Or both Traveling SideKick & SideKick at $125.00.*

To order by phone, or for a dealer nearest you,

call (800) 255-8008;

in CA call (800) 742-1133

Send me ___ Traveling SideKick(s) at $ ___
Send me ___ of both SideKicks at $ ___
Subtotal $ ___
Outside USA add $10 per copy $ ___
CA and MA res. add sales tax $ ___
Amount enclosed $ ___

Prices include shipping to all U.S. cities

Payment: VISA MC Bank Draft Check

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**Special Introductory Offer until September 1, 1986*

***YES, within 60 days of purchase, should you find that this product does not perform in accordance with our claims and representations, just call our customer service department and we will gladly arrange for a refund.*

Minimum System Requirements:
256 K
IBM PC, XT, AT and true compatibles
TS6

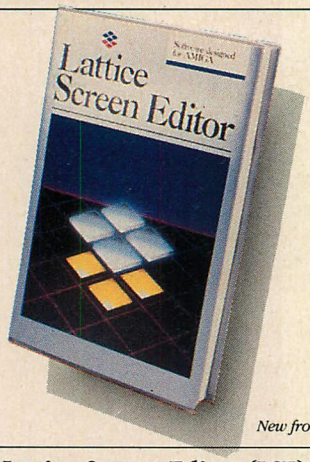
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CIRCLE NO. 250 ON READER SERVICE CARD

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New from Lattice



Drafix I by FORESIGHT

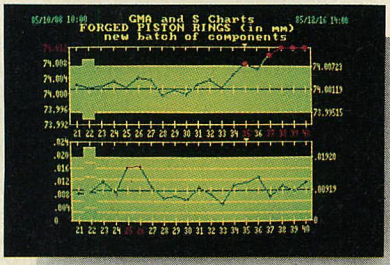
The **Lattice Screen Editor (LSE)** is a fast, flexible, multiwindow editor that is designed specifically for programmers. The multiwindow feature allows two files to be edited simultaneously and provides cut-and-paste functions between files. LSE features standard editor functions, such as block move, keyboard macros, variable tab settings, and insert text entry, as well as special features, such as an error tracking mode and three assembly language input modes. LSE supports the entry of any eight-bit character into the text for special graphics or foreign character sets. $125.
Lattice Inc., P.O. Box 3072, Glen Ellyn, IL 60138; 312/858-7950

CIRCLE 332 ON READER SERVICE CARD

A line of products for local and wide area networks has been announced by **3COM Corporation**. The **3+** products support internetworking, dial-in access to network resources by remote PCs, electronic mail within and across networks, and communications with mainframe computers. The line includes **3+Share**, a distributed PC netwrok operating system that provides file service, print service, naming service, and the software base for the rest of the products. **3+Route** interlinks two or more 3+ networks using asynchronous public phone lines or dedicated high speed links. **3+Remote** furnishes remote stand-alone PCs with full network access over phone lines. **3+Mail** permits store-and-forward electronic mail transfer among workstations on a single network, separate networks joined by 3+Route, and stand-alone PCs running 3+Remote. **3+Menus** provides menus and windows for access to network resources and applications. **3+3270** allows networked PCs to emulate IBM 3278/79 terminals. **3+Path** allows easy migration from 3Com's EtherSeries networks to 3+ networks. 3+Share five-user, $550 per server, unlimited, $1,100; 3+Mail, five-user, $250, unlimited, $500; 3+Menus, five-user, $150 per server, unlimited, $300; 3+Remote, $295 per remote workstation; 3+Route, $1,250 per server; 3+Path, $500 per server.
3Com Corporation, 1365 Shorebird Way, P.O. Box 7390, Mountain View, CA 94039; 415/961-9602

CIRCLE 336 ON READER SERVICE CARD

QScan, a statistical process control system for improving industrial quality, productivity management, and decision making, uses statistical process control techniques and software technology to monitor industrial processes, estimate



QScan screen

manufacturing process capabilities, design acceptance sampling plans, and model and analyze economics. Introduced by **ProScan, Inc.**, QScan supports monochrome systems and color systems with graphics cards, high-resolution monitors, and plotters. Dual-monitor configurations also are supported, and hard-copy output can be printed and plotted directly from the screen displays. Site license fee, $20,000.
ProScan, Inc., 13740 Research Blvd., Q-2, Austin, TX 78750; 512/250-1173

CIRCLE 328 ON READER SERVICE CARD

SNAPSHOT STORAGE SCOPE is a menu-driven digital storage oscilloscope package for the PC, PC/XT and PC/AT, designed for realtime collection and display of analog data. Developed by **HEM Engineering Company**, SNAPSHOT features digital or analog acquisitions, window displays, absolute and relative cursor readouts, time and magnitude readouts, channel labels, *X* and *Y* zooming and offset, selective recording of data to disk, and regraphing of stored data. Compatible with analog I/O boards by Metrabyte and Data Translation, its commands and parameters are issued through menus. $495; demo disk, $8.
HEM Engineering Company, 17025 Crescent Drive, Southfield, MI 48076; 313/559-5607

CIRCLE 334 ON READER SERVICE CARD

Drafix I, a CAD software package introduced by **FORESIGHT Resources Corporation**, features a visual user interface, including pop-up menus that remain on the screen at all times and roll-down menus that appear when the user makes a selection from a main menu. Drafix I provides geometry creation and editing capabilities as well as advanced copy and move operations, such as translation, rotations, scaling, and mirroring. Full annotation features include automatic dimensioning, crosshatching, and note entry/editing. $295.
FORESIGHT Resources Corporation, 34 Corporate Woods, 10950 Grandview, Overland Park, KS 66210; 800/231-8574, 913/841-1121

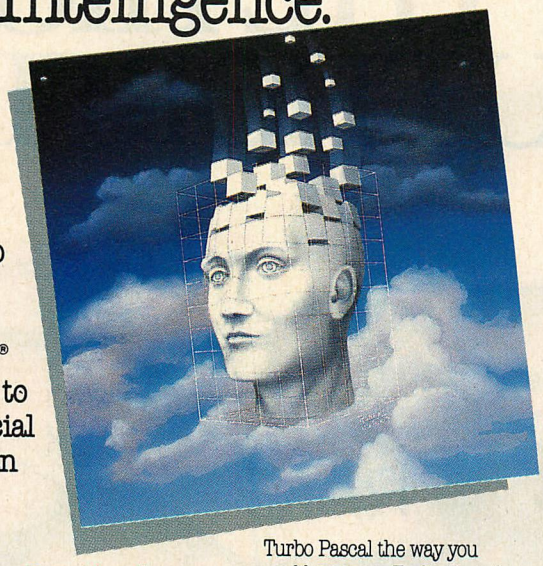
CIRCLE 340 ON READER SERVICE CARD

WindowPane, from **LUMINIX Corporation**, is a graphics window manager and menu database that allows the creation of graphics viewports as well as text windows on bit-mapped displays. Scrolling and word wrapping is supported within text windows. Pull-down, pop-up window menu functions are provided, and interactive menu design as well as canned window menus are supported. WindowPane works with medium- and high-resolution graphics boards. $99.
LUMINIX Corporation, 7700 Edgewater Drive, Suite 818, Oakland, CA 94621; 415/632-1044

CIRCLE 330 ON READER SERVICE CARD

Step-by-step tutorial, demo programs with source code included!

Borland introduces Turbo Prolog,™ the natural language of Artificial Intelligence.

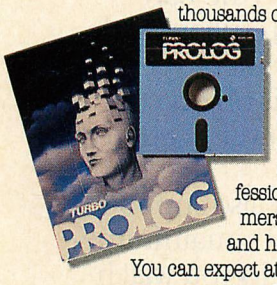


Prolog is probably the most powerful computer programming language ever conceived, which is why we've made it our *second* language—and "turbocharged" it to create Turbo Prolog.™

Our new Turbo Prolog brings supercomputer power to your IBM® PC and introduces you step-by-step to the fascinating new world of **A**rtificial **I**ntelligence. And does all this for an astounding $99.95.

Turbo Prolog is to Prolog what Turbo Pascal® is to Pascal!

Our Turbo Pascal astonished everyone who thought of Pascal as "just another language." We changed all that—and now Turbo Pascal is the de facto worldwide standard, with hundreds of thousands of enthusiasts and users in universities, research centers, schools, and with professional programmers, students, and hobbyists.



You can expect at least the same impact from Turbo Prolog, because while Turbo Prolog is the most revolutionary and natural programming language, it is also a complete development environment—just like Turbo Pascal.

Turbo Prolog radically alters and dramatically improves the brave new world of artificial intelligence—and invites you into that fascinating universe for a humanly intelligent $99.95.

Even if you've never programmed before, our free tutorial will get you started right away

You'll get started right away because we have included a complete step-by-step tutorial as part of the 200-page Turbo Prolog Reference Manual. Our tutorial will take you by the hand and teach you everything you're likely to need to know about Turbo Prolog and artificial intelligence.

For example: once you've completed the tutorial, you'll be able to design your own expert systems utilizing Turbo Prolog's powerful problem-solving capabilities.

Think of Turbo Prolog as a high-speed electronic detective. First you feed it information and teach it rules. Then Turbo Prolog "thinks" the problem through and comes up with all the reasonable answers—almost instantly.

If you think that this is amazing, you just need to remember that Turbo Prolog is a 5th-generation language—and the kind of language that 21st century computers will use routinely. In fact, you can compare Turbo Prolog to Turbo Pascal the way you could compare Turbo Pascal to machine language.

You get the complete Turbo Prolog programming system for only $99.95

You get a complete Turbo Prolog development system including:

- The lightning-fast Turbo Prolog incremental compiler and the interactive Turbo Prolog editor.
- The 200-page reference manual which includes the step-by-step Turbo Prolog tutorial.
- The *free* GeoBase™ natural query language database including commented source code on disk—ready to compile. GeoBase is a complete database designed and developed around U.S. geography. It includes cities, mountains, rivers, and highways, and comes complete with natural query language. Use GeoBase immediately "as is," or modify it to fit your own interests.

So don't delay—don't waste a second—get Turbo Prolog now. $99.95 is an amazingly small price to pay to become an immediate authority—an instant expert on artificial intelligence! The 21st century is only one phone call away.

Turbo Prolog 1.0 Technical Specifications

Programming System Features

- ***Compiler:*** Incremental compiler generating native in-line code and linkable object modules. The linking format is compatible with the PC-DOS linker. Large memory model support. Compiles over 2500 lines per minute on a standard IBM PC.
- ***Interactive Editor:*** The system includes a powerful interactive full-screen text editor. If the compiler detects an error, the editor automatically positions the cursor appropriately in the source code. At run-time, Turbo Prolog programs can call the editor, and view the running program's source code.
- ***Type System:*** A flexible object-oriented type system is supported.
- ***Windowing Support:*** The system supports both graphic and text windows.
- ***Input/Output:*** Full I/O facilities, including formatted I/O, streams, and random access files.
- ***Numeric Ranges:*** Integers: −32768 to 32767; Reals: 1E−307 to 1E+308
- ***Debugging:*** Complete built-in trace debugging capabilities allowing single stepping of programs.

YES! I want the best

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CA and MA res. add applicable sales tax: $ ____

Amount enclosed: $ ____

This price includes shipping to all US cities

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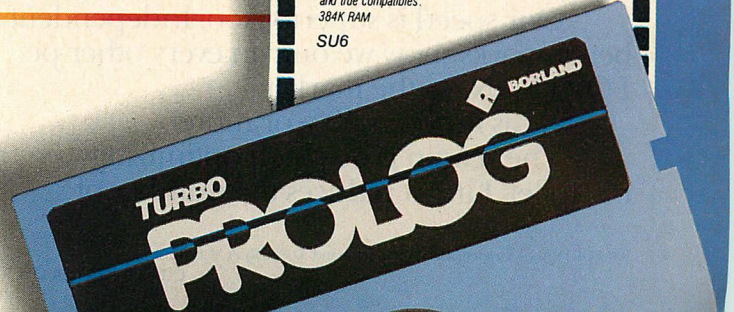
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**YES, within 60 days of purchase, should you find that this product does not perform in accordance with our claims and representations, just call our customer service department and we will gladly arrange for a refund.*

Minimum system requirements:
IBM PC, XT, AT, and true compatibles.
384K RAM

SU6



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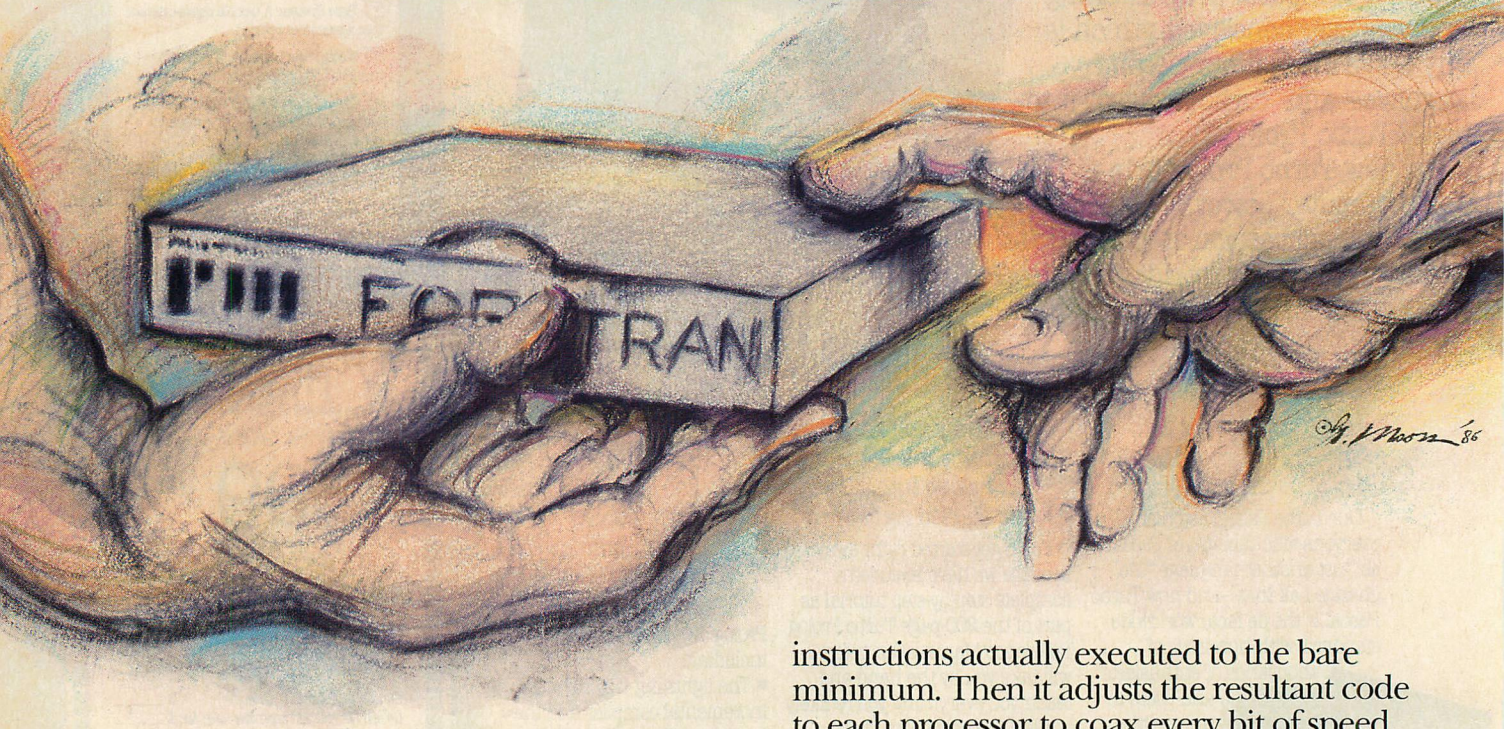
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Other Borland Products include Turbo Pascal; Turbo Tutor; Turbo Lightning; Turbo Database Toolbox; Turbo Graphix Toolbox; Turbo Editor Toolbox; Turbo GameWorks; SuperKey; SideKick; SideKick, The Macintosh Office Manager; Reflex, The Analyst; and Traveling SideKick—all of which are registered trademarks or trademarks of Borland International, Inc. or Borland/Analytics, Inc.
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FORTRAN FROM THE HIGHEST AUTHORITY.



Using the right FORTRAN compiler can do wonders for your creativity. So why not go right to the top? Namely, Ryan-McFarland's RM/FORTRAN™.

RM/FORTRAN is nothing less than a mainframe FORTRAN compiler made for a pc. It's a full ANSI FORTRAN-77. And the only pc FORTRAN GSA-certified error-free at the highest level. So unlike other pc FORTRANs, it's not just based on the standard. It *is* the standard.

It's also full of extensions, like VAX, VS and FORTRAN-66. So you can port your mainframe or mini FORTRAN applications back and forth to your pc without losing anything in the translation.

Our speed is superior, too. Independent benchmarks show we outrun every other pc FORTRAN on the market.

By as much as 40% or more!

The reason is our high optimizing compiler. First, it reduces the number of instructions actually executed to the bare minimum. Then it adjusts the resultant code to each processor to coax every bit of speed from the hardware. The result is object code so fast and compact you may never need to go to the mainframe again.

Speaking of which, there's also support for arrays larger than 64K. And a mainframe-style interactive debugger to help you watch your language in development.

RM/FORTRAN is available for machines based on the 8086/8088/80286 processor family, as well as all 68000-based machines. A version of RM/FORTRAN is also available under the catchy name, *IBM PC Professional FORTRAN by Ryan McFarland,* at your neighborhood IBM® Product Center.

Or get in touch with us directly at (213) 541-4828, or 609 Deep Valley Drive, Rolling Hills Estates, CA 90274.

And then you can rest.

RYAN-McFARLAND

Masters of the Language.

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CIRCLE NO. 174 ON READER SERVICE CARD



GCLISP 286 by Gold Hill Computers



Crosstalk XVI version 3.6

Gold Hill Computers, Inc. has released a high-performance artificial intelligence development system, the **GCLISP 286 Developer**. It includes a large memory interpreter and compiler, editor, tutorial, and on-line help system, and supports lexical scoping, packages, and transcendental functions. $1,195.

The company also has introduced the **Golden Common LISP (GCLISP) Network**, which provides an Ethernet connection between PCs and Symbolics LISP machines. Services provided by the GCLISP Network include a session layer interface and a Symbolics remote evaluation capability. In addition, the GCLISP Network provides file transfer, remote terminal login, electronic mail, and remote print service using one or more Symbolics machines. $395 per PC node.
Gold Hill Computers, 163 Harvard Street, Cambridge, MA 02139; 617/492-2071

CIRCLE 343 ON READER SERVICE CARD

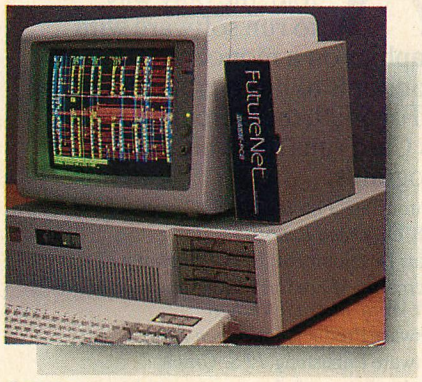
ASYSTANT Ready-Run Scientific Software is a menu-driven package for scientists, engineers, and researchers that is suitable for advanced applications; it requires no programming or computer expertise. Developed by **Macmillan Software Company**, ASYSTANT offers data reduction, as well as analysis and graphics capabilities for on-the-spot solutions. Another version, **ASYSTANT +**, adds data acquisition, built-in interactive data manipulation and analysis, and high-resolution color graphics.
ASYSTANT, $495; ASYSTANT +, $895.
Macmillan Software Company, 630 Third Avenue, 8th Floor, New York, NY 10017; 800/348-0033; in New York, 212/702-3241

CIRCLE 338 ON READER SERVICE CARD

Raima Corporation announced version 2.1 of **db_Vista**, a database management system for software development in the C programming language that is designed for use with DOS or UNIX-like operating systems. The new version features improved B-tree key field handling that allows the user to scan multiple keys at a time, a key file rebuild utility, a database consistency check utility, and file transfer utilities for dBASE, R:Base, and ASCII files. db_Vista includes a royalty-free run-time license. With source, $990; without source, $495.
Raima Corp., 12201 S.E. Tenth Street, Bellevue, WA 98005; 800/843-3313, 700-992 at the tone; 206/747-5570

CIRCLE 337 ON READER SERVICE CARD

DASH-PCB Layout from **FutureNet Corporation** is an expert system that lays out and routes printed circuit boards on a PC. The user is assured absolute minimum board size and number of circuit layers when using DASH-PCB, because of the product's expert multi-



DASH-PCB Layout by FutureNet

strategy (EMS) router, which executes a sequence of five routing algorithms. DASH-PCB runs in realtime. English-like commands make the system easy to use. Standard features include gate and pin swapping, step-and-repeat macros for building busses, and an upload/download capability for interfacing with host VAXs and IBM mainframes. $13,000.
FutureNet Corporation, 9310 Topanga Canyon Blvd., Chatsworth, CA 91311; 818/700-0691

CIRCLE 342 ON READER SERVICE CARD

Microstuf, Inc.'s upgrade of **Crosstalk XVI (3.6)** is compatible with IBM TopView. Together they permit file transfer via modem while using a word processor. The Kermit file-transfer protocol has been added to 3.6, and it permits high transfer speeds, up to 115,200 bps. Crosstalk now automatically sets baud rates when working with modems that have an autoset feature. RS-232 status lights, added to the Crosstalk screen display, indicate the status of seven circuits in the modem. $195.
Microstuf, Inc., 1000 Holcomb Woods Parkway, Roswell, GA 30076; 404/448-3688

CIRCLE 331 ON READER SERVICE CARD

A C cross compiler implemented for DOS running on the Intel 8086/88, 80186/188, and 80286 family of microprocessors is available from **Microtec Research**. This compiler, called **High C**, conforms to ANSI standards and supports ROMable code for embedded applications, nested functions passable as parameters, and a full set of memory models. The High C software package includes the compiler, the runtime libraries necessary to produce an executable program from the output of the compiler, a set of source code header files, a cross-reference mechanism that works on several program modules at one time, and Microtec's ASM186L cross assembler. $1,550.
Microtec Research, 3930 Freedom Circle, Santa Clara, CA 95054; 800/551-5554; in California, 408/733-2919

CIRCLE 339 ON READER SERVICE CARD

Erratum: In the February 1986 Tech Releases (p. 32), the price of the **Superset, Inc. X/48 Graphics Extension Processor** should be $19,900.

The material that appears in Tech Releases is based on vendor-supplied information. These products have not been reviewed by the PC Tech Journal *editorial staff.*

If you want to run software with graphics on your monochrome monitor, we have some bad news.

As we're sure you've been told, the only way to run software with graphics on a monochrome monitor is to buy a graphics card.

For $499, the Hercules Graphics Card runs these best-selling programs:

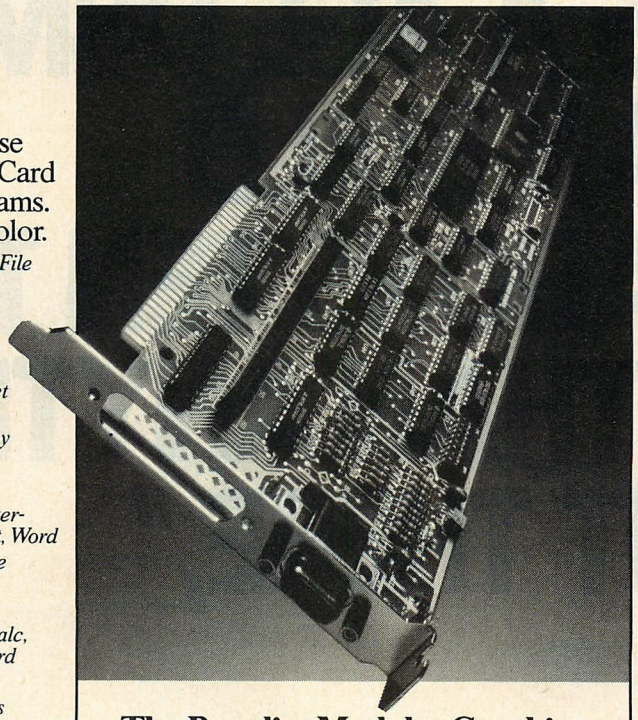
Ashton-Tate, *Framework*
BPS, *Overhead Express*
Lotus Development, *1-2-3, Symphony*
MicroSoft, *MicroSoft Flight Simulator, MicroSoft Word, MicroSoft Chart*
Software Products Int., *Open Access*
Software Publishing, *PFS: Graph*
Sorcim, *Supercalc 3*

In monochrome only.

And some good news.

For $395, the Paradise Modular Graphics Card runs all these programs. In monochrome. And in color.

Arrays/Continental Software, *Ultra File*
Ashton-Tate, *Framework*
BPS, *Overhead Express*
Brightbill-Robert, *Graphix Partner*
Chang Labs, *GraphPlan*
Dow Jones & Co., *Dow Jones Market Analysis*
Lotus Development, *1-2-3, Symphony*
MicroPro, *Chartstar, Planstar*
MDBS, *Knowledge Manager*
MicroSoft, *Basic Compiler, Basic Interpreter, Chart, Flight Simulator, Project, Word*
PC Software of San Diego, *Executive Picture Show*
Prentice-Hall, *Execuvision*
Schuchardt Software Systems, *Intecalc, Intemate, Intepert, Inteplan, Inteword*
Softrend, *Aura*
Software Products Int., *Open Access*
Software Publishing, *PFS:Graph*
Sorcim, *SuperCalc 3*
Summa Software, *Winning On Wall Street: Trader's Forecast, Winning On Wall Street: Trader's Data Manager*
Advanced Ideas, *The Game Show, Master Match, Tic Tac Show*
CBS Software, *Big Bird's Special Delivery, Dinosaur Dig, Ernie's Magic Shapes*
Davidson & Associates, *Math Blaster!, Word Attack!*
Designware, *The Grammar Examiner, Math Maze, Language Arts, Spellicopter, States & Traits, Trap-a-zoid*
Developmental Learning Materials, *Alien Addition, Alligator Mix, Demolition, Division, Dragon Mix, Meteor Multiplication, Minus Mission*
Eduware, *Algebra I, Algebra 2, Algebra 3, Algebra 4, Algebra 5*
Individual Software, *Professor Pixel, The Instructor, The Typing Instructor*
Knoware, *Knoware*
Scarborough Systems, *Mastertype, Songwriter*
Learning Co., *Addition Magician, Magic Spells, Moptown Parade, Number Stomper, Reader Rabbit*
Scholastic, *Turtle Tracks*
Sierra On-Line, *Dragon's Keep, Troll's Take*
Simon & Schuster, *Typing Tutor III*
Spinnaker Software, *Alphabet Zoo, Delta Drawing, Fraction Fever, Hey Diddle Diddle, Kids on Keys, Kindercomp, Rhymes & Riddles, Story Machine*



The Paradise Modular Graphics Card runs all the popular programs Hercules does, plus 150 more.

Springboard, *Early Games for Young Children, Make a Match, Piece of Cake Match, Quizagon*
Thoroughbred Software, *Exploring the Amazing Food Factory, The Fascinating Story of Cell Growth, How Plants Grow, Migrating Molecules, Mastering Units of Measurement, Photosynthesis*
Unicorn Software, *Funbunch, Ships Ahoy, Ten Little Robots*
Digital Research, *DR Logo*
Energtonics, *Energraphics*
Fox & Geller, *dGraph, OZ*
Graphic Communication, *Graphwriter BASIC, Graphwriter Combination, Graphwriter Extension*
Harvard Associates, *P.C. Logo*
Innovative Software, *Fast Graphs*
Mouse Systems, *PC Paint*
PC Software of San Diego, *PC Crayon*
Peachtree Software, *Business Graphics System*
Arktronics, *Jane*
Eagle Software Publishing, *Personal Financier*
Monogram, *Dollars and $ense*
Penguin Software, *Graphics Magician*
Sierra On-Line, *Homeword*
Adventure Enterprises, *Sea Dragon*
Atarisoft, *Centipede, Defender, Dig Dug, Donkey Kong, Pac Man, Robotron, Stargate*
Avalon Hill Game Company, *Andromeda Conquest, Computer Football Strategy, Computer Stocks & Bonds, V.C., Voyager*

Broderbund Software, *Serpentine*
CBS Software, *Match-Wits, Mystery Master: Murder by the Dozen*
Hayden Software, *Sargon III*
Innovative Design Software, *Pool 1.5*
Intelligent Statements, *Asylum*
Microlab, *Crisis Mountain, Death in the Caribbean, Dino Eggs, High Rise, Miner 2049er*
Muse Software, *Castle Wolfestein*
Odesta, *Backgammon, Checkers, Chess, Odin*
Origin Systems, *Ultima III*
Orion Software, *J-Bird*
PC Software of San Diego, *Championship Blackjack*
Penguin Software, *The Quest*
Priority Software, *Forbidden Quest*
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TED MIRECKI

Linking Library Routines

Assembly language programmers can keep library routines with the resident portion of a program, where they are available for use as needed.

Assembly language programmers develop libraries to be incorporated into programs at link time. Unless precautions are taken, however, the linker places these modules after the main module, and, in some cases (such as a resident program), a routine's position within a program is critical.

A resident program is typically written in two parts: a resident portion that implements the desired function and a portion of initialization code that hooks the program into the interrupt system. Usually, the initialization code is not needed after the program has been made a part of the system. Consequently, it does not have to remain with the resident code and is placed after that portion of the program in memory that is returned to the operating system. Any routines that the linker had placed after the initialization portion of the program are likewise returned to the operating system and are no longer available for use by the resident code.

A simple solution to this problem is to have the linker place all library routines at the end of the resident portion of a program, but *ahead* of the initialization code.

This can be done by using two segments—one for the resident code and the other for the initialization code. The segment containing the resident code must have the same name as the one containing the routines to be linked in. If the program is to be converted to a .COM file, a group containing the two segments also must be defined in the main program. Defining the group in the subroutine is not necessary, so the same object code can be linked into a program that defines a group with any name or with no name at all.

The skeleton program shown in listings 1 and 2 is not executable. If, however, it is assembled, linked, and converted to a .COM file, it then can be examined with DEBUG to demonstrate the resulting load module structure. After SUBR.ASM is assembled, it can be placed in an object library or named in the link command: LINK RESIDENT+SUBR. After RESIDENT.ASM is assembled, RESIDENT.COM can be disassembled to show that its parts are organized in the proper sequence: the resident portion is first, followed by the subroutine, and, finally, the initialization code.

Note that the jump instruction at the entry point (offset 100H) assembles correctly as a near jump even though its target label is located in another segment. The ASSUME directive tells the assembler to calculate code and data segment offsets from the start of the group, not of each segment, so this label can be reached with an offset. ASSUME produces automatic group-relative addressing for jumps, calls, and the LEA instruction, but not for the OFFSET operator. In that case, the address of the offset that is to be loaded must be preceded with the group name prefix. (See listings 1 and 2.)

In IBM's Macro Assembler (all versions), the default arranges segments alphabetically. The default in Microsoft's Assembler, versions 3 and 4, arranges segments in the order that they appear in the source code.

Ted Mirecki has a master's degree in computer science and 20 years of experience in information processing. He is a corporate planner and is responsible for developing decision support systems.

LISTING 1: RESIDENT.ASM

```
COM         GROUP   CODE,INIT
            ASSUME  CS:COM, DS:COM, ES:COM
            EXTRN   SUBR:NEAR
CODE        SEGMENT PUBLIC 'CODE'
            ORG     100H
START:      JMP     INITPROC        ;GO PERFORM INITIALIZATION
RESDATA     DW      ?               ;DATA FOR RESIDENT PORTION
RESIDENT    PROC
            NOP                     ;PERFORM RESIDENT FUNCTION
            NOP
            CALL    SUBR            ;CALL RESIDENT SUBROUTINE
            IRET
RESIDENT    ENDP
CODE        ENDS
INIT        SEGMENT BYTE PUBLIC 'CODE'
ENDRES      LABEL   BYTE            ;MARK END OF RESIDENT PORTION
INITDATA    DW      ?               ;DATA FOR INITIALIZATION
INITPROC    PROC
            NOP                     ;PERFORM INITIALIZATION
            NOP
                                    ;EXIT & REMAIN RESIDENT
            MOV     AX,CS           ;MAKE SURE ES POINTS TO PSP
            MOV     ES,AX
            MOV     DX,OFFSET COM:ENDRES
            MOV     CL,4
            SHR     DX,CL           ;NO. PARAGRAPHS RESIDENT
            MOV     AX,3100H        ;EXIT & REMAIN RESIDENT
            INT     21H
INITPROC    ENDP
INIT        ENDS
            END     START
```

LISTING 2: SUBR.ASM

```
CODE        SEGMENT BYTE PUBLIC 'CODE'
            ASSUME CS:CODE
            PUBLIC SUBR
SUBR        PROC    NEAR
            PUSH    AX
            PUSH    BX
            POP     BX
            POP     AX
            RET
SUBR        ENDP
CODE        ENDS
            END
```

TECH NOTEBOOK 61

AUGIE HANSEN

Using DOS Loops

The FOR loop can be used in batch files and at the DOS prompt to automate many otherwise tedious processes.

PC users can configure their systems to automate certain processes at boot time, using the batch processing capabilities that have been available in DOS from the very beginning. For example, AUTOEXEC.BAT files can be written to call the programs of multipass compilers with only a single command from the user. In DOS version 2.0, more sophisticated batch file capabilities, such as looping (FOR and GOTO), conditional branching (IF with the options NOT, ERRORLEVEL, EXIST and ==), and parameter shifting (SHIFT) were introduced. SHIFT allows more than ten replaceable parameters on a command line.

The FOR loop has many applications. It can be used in batch files that process one or more source files through assemblers, C and Pascal compilers, or linkers. When the loop is part of a batch file, any variables used in the test condition must be preceded by a double percent sign prefix, as in

```
FOR %%f IN (*.c) DO ccm %%f
```

where **ccm** is a C compiler control program that calls the individual passes of the compiler.

The general form of the DOS FOR loop is

```
FOR %%<variable> IN (<set>) DO <command>
```

In this example, %%<**variable**> is first sequentially assigned the value of each member of <**set**>, then <**command**> is executed. <**Command**> can contain expressions involving %%<**variable**>, included at the discretion of the user.

If the syntax is modified slightly, the FOR command can be used to perform looping operations outside of batch files at the DOS prompt. (Although this has been true since the introduction of the FOR loop in batch files, it was not documented by IBM until DOS 3.0.) If preceeded by a single percent sign, the FOR command will execute loops at the DOS prompt. For example, the following command line, typed at the DOS prompt, uses ECHO to display its arguments for each file name that has a .PAS extension:

```
FOR %f IN (*.pas) DO echo %f
```

Programs that take only a single file name specification, such as many common printer programs, can be a nuisance to run on a directory of files. Most recent programs accept the DOS wild cards (* and ?) in both file names and path names; this allows users to create ambiguous names that refer to sets of files. However, many programs (especially older programs) do not accept these wild cards.

For example, if a printer program called **lp** does not accept wild-card file specifications, instead of retyping the print request for each assembly language source file, the user simply can type the following command

```
FOR %f IN (*.asm) DO lp %f
```

to print all of the files sequentially with a single command. (This assumes that **lp** skips page boundaries and starts printing each separate file at the top of a new page.) The set specified by ***.asm** matches only files in the current directory that have an .ASM extension. Using ***.*** would match all files in the current directory and ignore any subdirectory names and volume labels that may be present.

The FOR loop can be used in other situations, also. Suppose, for example, that the user mistakenly copies a large number of files from a floppy disk into the wrong subdirectory on a hard disk. The user wants to remove the files that were copied by mistake, but, of course, does not want to lose the many other subdirectories and files that exist in the subdirectory. This can be accomplished easily with the help of a FOR loop. First, the floppy disk containing the original files should be write-protected. The user then can place the protected floppy disk in drive A: (the default drive) and type the following command:

```
FOR %f IN (*.*) DO del c:<wrongdir>\%f
```

<**Wrongdir**> is the full path name to the subdirectory containing the unwanted files. This command uses the set of all files found on drive A: as a loop list for the DEL command, which operates on drive C:. It takes each item that appears in the set in turn and substitutes that item as the variable. Thus, it is able to erase one file at a time until the list is exhausted and remove all of the unwanted files without disturbing any other subdirectories or files stored on the disk. This one command saves the user from what otherwise could have been a tedious process.

Users should note that A: must be used as the default drive when working with this example. If it is not, the command variable might include an erroneous path.

Another example of a useful interactive loop construct involves the creation of sets of files based on a template file. The template file contains all the data that are common to a set of files for a given application. The remaining files can be created by using the following command:

```
FOR %f IN (01 02 03 04 05 06 07 08 09 010 011 012)
  DO copy template file%f
```

The user could create the files manually by using the copy command again and again. However, the loop allows the work to be accomplished with only one command; furthermore, any common data in the template loop can be positioned and expressed identically on the resulting output, producing a consistent appearance with little effort.

Augie Hansen is the owner of Omniware, a software development and training firm that specializes in UNIX and DOS systems.

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CIRCLE NO. 208 ON READER SERVICE CARD

TECH NOTEBOOK 62

MICHAEL COVINGTON

Reset the Printer

This program manipulates the INIT line of the parallel printer interface to cause any printer to reset to default values.

Most programmers know that an Epson printer can be reset by sending it an Esc character (ASCII code 27) followed by the character @. Resetting the printer makes it act as if it had just been turned off and then on again. All special print modes are cancelled, the line spacing and margins return to the default values, and the current paper position is defined to be top of form.

The trouble is, not every printer is able to recognize Esc @ as a command. For example, if an IBM Graphics Printer or Proprinter is sent an Esc @, nothing happens. Other printers may actually print the @. Fortunately, the hardware provides a different, little-known means to reset almost any parallel printer. In addition to the various wires that are connected to transmit data to the printer, the parallel printer interface contains a line called INIT. This line normally carries a high (positive 5-volt) signal. If INIT is briefly taken low (to 0 volts), the printer automatically resets itself. If a printer does *not* reset when INIT goes low, it really cannot claim to be a Centronics-parallel-port compatible printer.

The programs shown in listings 1, 2, and 3 demonstrate the manipulation of the INIT line in BASIC, Turbo Pascal, and assembly language, respectively. In each case, the first step is to examine memory location 0040:0008 (hex), which contains the address of the first I/O port that serves device LPT1 (the parallel printer). The address of the port that controls INIT is obtained by adding 2 to the starting address. As a check, this final port address is normally 3BEH for the printer adapter on the IBM Monochrome Display card; the normal address for a printer adapter by itself is 37AH.

At this point, two values are output to that port—first 232 (binary 11101000), then 236 (binary 11101100). This sets the INIT bit (bit 2) to 0, then sets it to 1.

INIT has to be low long enough for the printer to notice, so in between outputting the two values, the computer is made to kill time in a delay loop. Actually, an IBM Graphics Printer will reset if INIT stays low for a mere 50 microseconds, but other printers may take longer. Because the process of resetting takes about half a second, these programs hold INIT low for approximately 0.1 second. This should be long enough for even the slowest printer, and it ensures that the programs will work correctly even if run on a much faster processor in the future.

Michael Covington is a research assistant at the Advanced Computational Methods Center at the University of Georgia. He is implementing a Prolog-based language on a CYBERPLUS supercomputer.

LISTING 1: PRRESET.BAS

```
10 ' Interpreted BASIC program
20 ' to reset any parallel printer
30 DEF SEG = &H40
40 PORTNO = 2 + PEEK(8) + 256*PEEK(9)
50 OUT PORTNO,232
60 FOR DELAY = 1 TO 50: NEXT
70 OUT PORTNO,236
```

LISTING 2: PRRESET.PAS

```
program prreset;

{ Turbo Pascal program to initialize any parallel printer }

var  address: integer absolute $0040:$0008;
     portno,
     delay:   integer;

begin
  portno := address + 2;
  port[portno] := 232;
  for delay := 1 to 2000 do {nothing};
  port[portno] := 236
end.
```

LISTING 3: PRRESET.ASM

```
; Assembly language program to reset any parallel printer
;
; This can be assembled "as is" to make a .COM file, or
; the instructions can be incorporated into your program.
;

cseg     segment
         assume   cs:cseg,ds:nothing
prreset  proc     far

         mov      dx,0040h
         mov      ds,dx
         mov      dx,ds:[0008h]
         add      dx,2       ; port address is now in DX

         mov      al,232
         out      dx,al      ; INIT line goes low

         mov      cx,32767
delay:   loop     delay      ; wait about 0.1 second

         mov      ax,236
         out      dx,al      ; INIT line back to normal

         int      20h        ; return to DOS

prreset  endp
cseg     ends
         end      prreset
```



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As the IBM PC family (and the associated pool of PC compatibles) expands, more and more CPUs in the Intel and NEC 16-bit lines are being used to run these systems, from the seminal 8088 to the powerful 80286. NEC has implemented the Intel architecture in its V20 and V30 chips (see "8088 vs V20," Juan Jimenez and Steve King, in this issue, p. 73). In the course of developing its line of chips, Intel has expanded the instruction set in several ways. The major changes in the 80286 have to do with its potential for virtual memory management and hardware-assisted context switching.

Although software developers have followed closely the introduction of these new features, they remain tantalizingly out of reach to most. Those whose code must perform across the entire CPU lineage must avoid the new instructions for fear that the code will be unusable on the majority of systems. With perhaps a couple of million 8086- and 8088-based PCs in use, few can afford to shut out such a sizeable market.

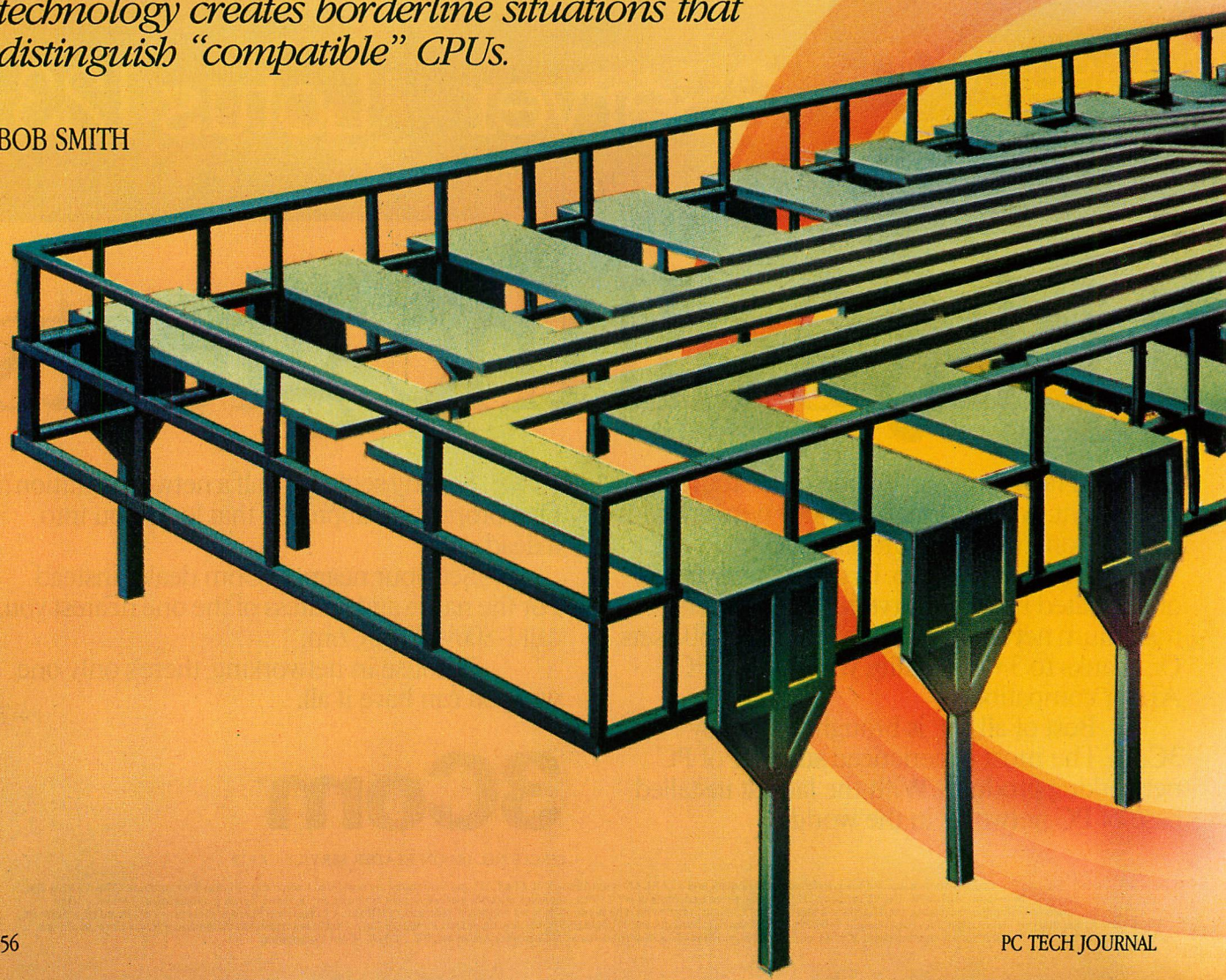
Nevertheless, the new CPUs can affect the developer even if he avoids all the *new* features. This is because the basic instructions of, for example, an 8088 are sometimes changed in a later version of that CPU or a newer model CPU, and they may execute differently. Knowing what the extended instructions do is not so necessary as knowing how the basic (8086/88) instructions have changed. Where they differ lie potential pitfalls to trap the unwary programmer.

The majority of Intel CPU instructions are sufficiently intuitive (they behave "as they should" according to an understanding of the logic behind them) so that experience gained in working with one CPU transfers smoothly to working with others in the family. A very few instructions seem to fall on a borderline—intuitive on the

Chips in Transition

Tension between upward compatibility and advancing technology creates borderline situations that distinguish "compatible" CPUs.

BOB SMITH



surface but quirky underneath. This can happen, for example, when the vendor's understanding of an instruction does not map one-to-one with that of the working programmer. Changes made by the vendor to certain instructions in developing next-generation products may contain some surprises.

The pitfalls are subtle but real, and they usually occur in these borderline situations. With the broad spectrum of CPUs used in IBM PCs and compatible systems, the risk of unknowingly running afoul of some change should not be ignored. The programmer cannot afford to develop code on one machine only to find that it does not run on a different model CPU or even a different version of the same CPU.

This article conducts an informal tour through the line of Intel and NEC 16-bit chips used in the PC family and compatibles. It focuses on differences in the basic instruction set and how to code around them. The goal is to provide guidelines for the developer whose code must work across the range of PCs and compatible systems.

Although Intel has gone to great lengths to provide upward compatibility, each CPU introduces some change that can be tested via software alone. The program in listing 1, CPUID, has been developed to identify each CPU in the line. (It also recognizes the NEC V20/30.) This program also can detect an error present in some early-model 8086/88 CPUs that causes them to perform differently than the design specifies. The deviation, discussed below, warrants replacement of the chip; it is, therefore, advisable to run CPUID on a system to detect such a CPU. This program executes on any PC or compatible running any version of DOS. The tests were chosen to work under all circumstances: only those instructions available on all chips are used.

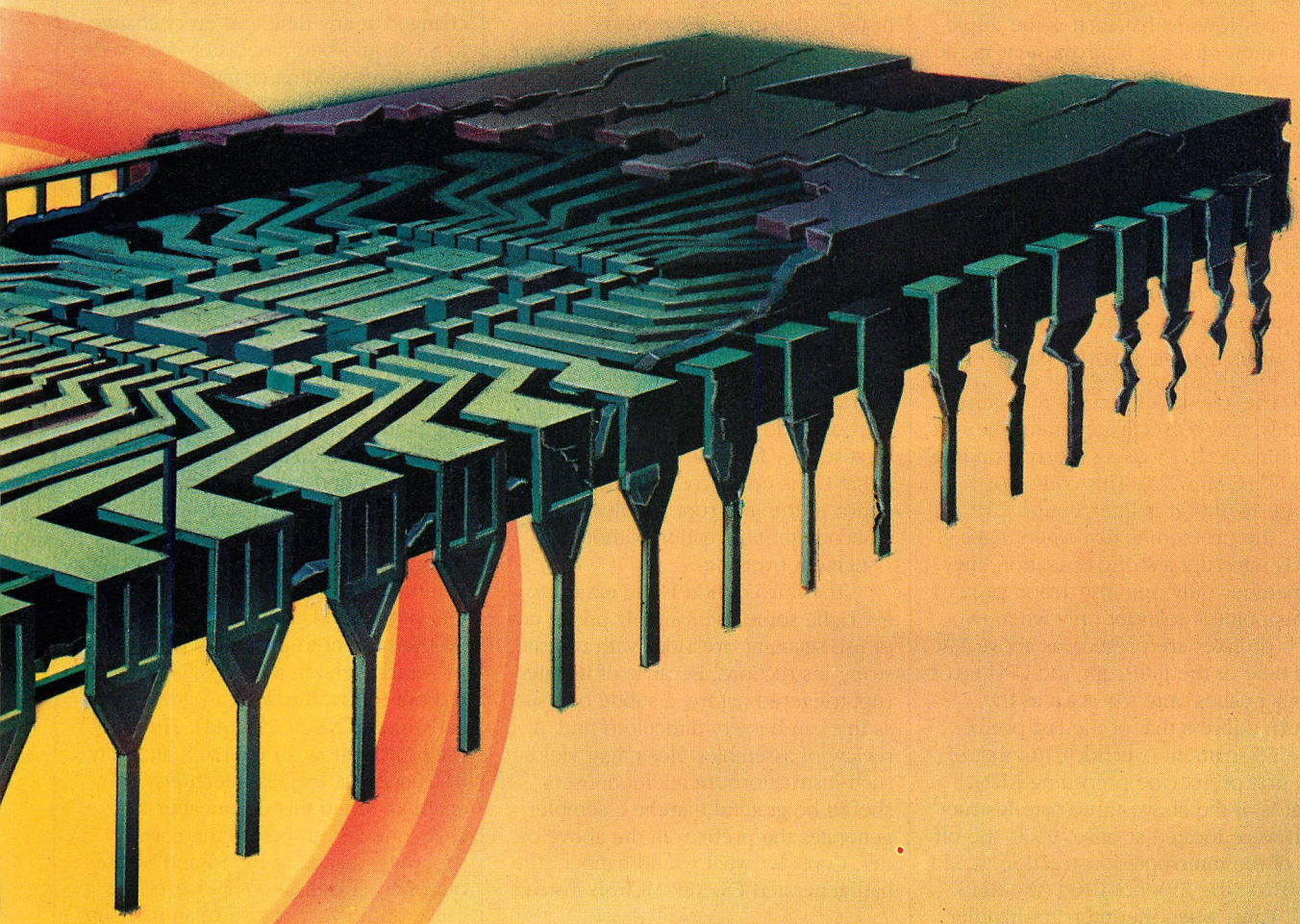


ILLUSTRATION • ALAN HASHIMOTO

FIGURE 1: *Test for CX*

```
L1:  REP     MOVS Byte Ptr ES:[DI],ES:[SI]
     JCXZ    L2          ; Jump if out of data
     LOOP    L1          ; Less one already moved,
                         ; restart if any remain
L2:  ...
```

This work-around for correcting the 8086/88 interrupt handler tests CX immediately after each interrupt instruction.

FIGURE 2: *Test for CMPS*

```
L1:  REPE    CMPS Byte Ptr ES:[DI],ES:[SI]
     JCXZ    L2          ; Jump if out of data
     JNE     L2          ; Jump if mis-match
     LOOP    L1          ; Less one already moved,
                         ; restart if any remain
L2:  ...
```

Testing CX within a CMPS loop is more complicated: both a mismatch and out-of-data condition must be anticipated.

8086/88 (AND V20/30)

The venerable 8086/88 CPUs provide the baseline for the tests. They are distinguished from their successors mainly by the absence of new features; later CPUs provide more capability, and in somewhat different ways. Failure to demonstrate any of the new capabilities tags a CPU as either an 8086 or an 8088. These two chips are distinguished from each other by a separate test described below. A look at some of the major differences reveals that each is the implementation of some improvement in the way the newer CPUs handle interrupts.

For example, suppose the programmer wants to move a chunk of data from one place to another. This sounds like a job for a repeated string move. Ordinarily the source segment is given by DS and the destination by ES. This time, however, he needs to move both to and from the ES segment (using a segment override) as in:

```
REP MOVS Byte Ptr ES:[DI],ES:[SI]
```

The assembler accepts this quite readily, and correctly generates the hex machine code F3 26 A4 (corresponding to REP ES:MOVSB). This code works properly until it is interrupted.

The problem is that when 8086/88 CPUs interrupt a string operation, they remember only one instruction prefix. (This point is relevant only when two such prefixes are present, as above.) At the time of the interrupt, the CPU incorrectly pushes onto the stack as the return address that of the last prefix (the ES segment override), not that of the first prefix (the preceding REP). That is, if the above three-byte instruction were located at offset 0100, the offset of the interrupted instruction would be 0101 (the ES), not 0100 (the REP).

Thus, when the interrupt handler returns, execution restarts, as it were, in the middle of the interrupted instruction. The ES:MOVSB part is executed once more (without the REP prefix), and execution continues with the next instruction in sequence. Note that CX is *not* decremented to account for the additional move, and the remaining CX-1 bytes requested to be moved are not. This behavior is most commonly encountered with the above string move, but is in fact endemic to all multiprefix interruptible instructions, such as REPx CMPS, on 8086/88 CPUs. Later model Intel CPUs (and NEC's V20/30) restart such interrupted instructions at the left-most prefix. In fact, this corrected operation is used in CPUID.COM to recognize the NEC CPUs.

Software developers might try one of the following work-arounds:

- Ensure interrupts are disabled before executing the instruction. If CX is large, this solution may be unacceptable because interrupts could be disabled for too long.
- Test CX immediately after each such instruction as is shown in figure 1. The approach for CMPS is slightly more complicated; it also must take into account proper early termination of the instruction (see figure 2), and similarly for REPNE CMPS (use JE L2). This approach is a good candidate for a macro. Some published work-arounds do not function correctly because they fail to account for the fact that CX is not decremented upon return of the interrupt handler.
- Recode the instruction without a segment override.

The third option is the easiest to get right; some users simply prefer not to use segment overrides with repeated string instructions. Because of its interrupt-triggered nature, a subtle bug such as this can be very difficult to find. A review of assembler files might yield such instructions. In addition, users should be grateful that the assembler generates the prefixes in the above order. Consider what would happen if it had generated ES: REP MOVSB instead.

STACK SWITCHES

Stack switches take place all the time; almost every time a program calls DOS, a stack switch occurs. Typically, this is done as follows:

```
MOV SS,NEWSTK_SEG
  MOV SP,NEWSTK_OFF
```

The data sheet for the 8086/88 says that a MOV to or POP of a segment register should be treated specially to ensure that no interrupt should be recognized until after the instruction following the MOV or POP. Such a prohibition is necessary only when changing SS, the stack segment register—that is, when switching stacks. The recommended way to switch stacks is to change SS first, then SP in the following instruction. Subsequently, SP may be changed at any time, but every change to SS should be immediately followed by a corresponding change to SP.

This is the reason the data sheet says that no interrupt should be allowed immediately after changing a segment register. That restriction allows the stack segment:offset address to be treated as a unit.

Consider what happens when an interrupt occurs. First, the current flags and the address of the next instruction are pushed onto the stack, and control is passed to the interrupt handler. This is the CPU's equivalent to keeping its finger in a book while it answers the phone. The interrupt handler does its job quickly and returns control to the interrupted routine. These interruptions take place all the time (such as the timer tick at 18.2 times per second or a communications interrupt at 120 characters per second) and are supposed to be transparent to programs.

Early version 8086/88s, however, did not follow the design (although early-model NEC CPUs did). The early Intel CPUs allow an interrupt after any instruction as long as interrupts are enabled. When this occurs after a change to SS but before the corresponding change to SP, SS and SP are out of synchronization. However, because of the very nature of an interrupt, they are about to be used in conjunction as the CPU writes the flags and return address of the interrupted instruction to the six bytes ending at SS:SP—using the new SS but the old SP. If the program shares code and/or data with its stack (as many programs do), this untimely interrupt can crash the system.

This problem was considered so serious by Intel that the company corrected it in later versions of the same chips (see "Tracing a Bug in the 8088," Tech Notebook 4, Will Fastie, September/October 1983, p.106). Nevertheless, a check of serial numbers indicates that the errant 8088s were used in the first 200,000 or so IBM PCs.

Software developers whose code might fail if run on such a deviant CPU can avoid this by ensuring that interrupts are disabled when switching stacks. Even if the code contains properly disabled interrupts, single-stepping through the stack switching code should be avoided if the CPU demonstrates the aforementioned behavior.

The user who suspects that his processor may be subject to this failure should run the CPUID.COM program. The program detects the problem by enabling the single-step interrupt just before a change to SS. If the single-step handler regains control immediately after the change, it means that the CPU is errant and should be replaced. If, instead, it executes the next instruction as well without interruption, the CPU is okay. Replacing a CPU is inexpensive—a new 8088 costs about $15—and it is a straightforward operation; moreover, replacing an errant chip can increase a system's reliability.

DIVIDE OVERFLOW

When a divide overflow occurs on an 8086/88, the CPU pushes onto the stack the address of the instruction following the one that signaled the divide overflow. This behavior makes error analysis and/or recovery difficult. In general, if all an interrupt handler is given is the address of the following instruction, it is not possible to search backwards through the instruction stream to identify reliably the beginning of the interrupted instruction. Independent of divide overflow, this is a problem faced by any debugger that permits backwards disassembly.

Two indeterminate situations compound the problem. First, the address operand of a DIV instruction may itself look like another DIV instruction. For example, the line

```
DIV Byte Ptr CS:[0F3F6H]
```

assembles to the hex values 2E F6 36 F6 F3. However, DIV BL assembles to F6 F3. When searching backwards through those bytes how is the F6 byte that begins the instruction distinguished?

A second problem in searching backwards is that it is impossible to determine whether or not a hex byte of (say) 2E preceding what may be a valid instruction is a segment override of CS or part of a preceding instruction.

These two problems are present in the 8086/88 and NEC V20/30, as well as the 80186/88; they are corrected in the 80286. In particular, the 80286 CPU pushes onto the stack the address of the instruction interrupted including any prefix such as a segment override.

80186/88

Except for the divide overflow situation just described, the 80186/88 corrects the problems mentioned thus far. However, it executes several instructions differently from its predecessors.

One difference is in its treatment of certain previously undefined op codes such as POP CS. Although 8086/88 behavior is undefined for such situations, something does happen with that instruction and in practice it is always the same: POP CS pops the top stack element into CS. As a result, the code must be prepared to execute in the new code segment with the old instruction pointer (now pointing to the next instruction in the old code segment).

Early version 8086/88s allow an interrupt after any instruction as long as interrupts are enabled.

The 80186/88 handles these situations quite differently. Instead of trying to change CS, it signals an interrupt 06H and lets the interrupt handler determine what to do. On a PC/AT (which has an 80286 that also signals an interrupt 06H in this case), the BIOS installs an interrupt handler for INT 06H, but it deals with external interrupts only and is of no help. Expect to warm boot an AT if it encounters an invalid op code. The moral of the story for software developers is to stick with defined and documented instructions only.

Another borderline situation for the 8086/88 that changed in the 80186/88 is the manner in which word writes that span a segment boundary are handled. Consider the instruction MOV DS:[0FFFFH], AX. On an 8086/88, AH is written to DS:[0000H]. On an 80186/88, AH goes to the next contiguous byte following DS:[0FFFFH], loosely represented as DS:[10000H]. A similar distinction exists with a PUSH if SP is 1.

Still another change introduced with the 80186/88 affects the way in which multibit shift and rotate instructions behave. These instructions use the value in the CL register to control the amount of shift/rotate. The 8086/88 CPUs use all eight bits of CL to determine the shift/rotate amount, thus allowing the shift of a 16-bit register up to 255 positions.

The Intel literature says that to reduce the maximum number of clock cycles devoted to any single instruction (and thus improve response to interrupts) Intel changed those instructions to use the low-order five bits of CL only; the high-order three bits are ignored. Thus, a way to test for this CPU (or the 80286) is to shift a register by an amount greater than 32. If the result reflects a shift by CL mod 32, the CPU is later than 8086/88. Shifting by exactly 32 to detect the difference does not work as expected (as discussed below).

The 80286 is recognized for its virtual memory management potential. Less well-known is the degree to which the basic instruction set was reworked.

The borderline situation for MOV DS:[0FFFFH], AX and other such segment overruns changed again. On the 80286, segment overruns signal interrupt 0DH. Unfortunately, on an AT this interrupt number performs double duty—it also can be signalled by an interrupt from the second parallel port, LPT2. If an interrupt handler for either LPT2 or segment overruns is installed, it should be coded according to the context in which it will be invoked. This can be accomplished by checking the in-service register (ISR) of the 8259. If IRQ5 (to which LPT2 is assigned) is not in service, then the interrupt is from a segment overrun, otherwise it is an interrupt from LPT2 (or a segment that is overrun within an LPT2 handler).

This CPU also changed the set of instructions considered as invalid op codes: additional instructions became invalid, others became valid. One of the now invalid 80286 instructions is MOV CS,AX (this is why early versions of Microsoft Word do not run on an AT).

A borderline situation on divide overflow also changed. On earlier model CPUs, a signed division (IDIV) with a quotient that ordinarily would be 80H or 8000H instead signals a divide overflow. The 80286 returns the correct result without problem.

The 80286 appears to have introduced its own share of problems as well. The *IBM PC/AT Technical Reference Manual* notes that under certain circumstances, POPF may allow an ex-

FIGURE 3: *Simulating a POPF*

```
  JMP   Short L2      ; Skip over IRET
L1:
  IRET                ; Pop the CS & IP pushed below along
L2:                   ; with the flags, our original purpose
  PUSH CS             ; Prepare for IRET by pushing current CS
  CALL L1             ; Push IP, jump to IRET
```

IBM recommends this sequence for cases in which code must not be interrupted during a POPF. It takes advantage of the fact that an IRET is equivalent to POP IP, POP CS, POPF.

FIGURE 4: *Shifting by Zero*

```
DATE Record     @YY:7,@MM:4,@DD:5

     AND        @AX,Mask @DD    ; Isolate day bits
     MOV        CL,@DD          ; Get shift amount

     SHR        AX,CL           ; Shift to low-order
     JZ         INVALID         ; It's an invalid date
```

A disturbing aspect of the above code is that it works, but for the wrong reason. Anything inserted between AND and SHR that sets the ZF flag can cause this sequence to fail.

ternal interrupt even if interrupts are disabled before and after the instruction. This circumstance is not at all special; in fact, similar circumstances occur throughout the operation of an AT under DOS, so beware. If the program code cannot afford to be interrupted during a POPF, a work-around is available. In those cases, IBM recommends simulating a POPF with the sequence shown in figure 3 (which is best placed into a macro). This code takes advantage of the fact that an IRET is equivalent (loosely) to POP IP, POP CS, POPF. Apparently IRET does not have the same problem as POPF.

Finally, another instruction that changed is the obscure PUSH SP. This instruction is mentioned only because it does provide a simple test for the presence of an 80286. In particular, the following code distinguishes that CPU from its predecessors:

```
PUSH  SP
POP   AX
CMP   AX,SP
JE    ITSA286
```

Earlier model CPUs decrement SP first, then write it out. The 80286 does the opposite, perhaps in an attempt to catch a stack underflow (interrupt 0CH) before changing the register.

NOTHING DOING

Some anomalies are evident across the entire line of CPUs. These can be as much a source of confusion as the differences in the basic instruction set.

Shifting by zero. The first aberration concerns the multibit shift and rotate instructions. For example, consider what should happen with

```
SHR  AX,CL
```

when CL is 0. Most programmers would conclude reasonably that nothing should happen. But consider both perspectives. The CPU is asked to shift or rotate by 0, so its operation tells it that it might as well ignore the instruction, which is, in fact, what the CPU does—it treats it as an NOP. This is incorrect. Now consider this problem from the programmer's point of view. In the following program fragment

```
SHR  AX,CL
JNZ  ...
```

AX is nonzero after the shift. Does the program branch or fall through?

A quick check of the IBM Macro Assembler instruction manual reveals that SHR sets or clears ZF just like any normal flag-waving instruction (the literature says "PF, SF, and ZF are updated normally as in logical instructions."). In an informal poll of programmers, all agreed the code would branch in all cases. This, however, is not the case; sometimes it does not.

As previously discussed, if CL is 0 (or a multiple of 32 on one of the later model CPUs), the CPU exits early from the instruction. In particular, it fails to modify any flags. Thus the action of the conditional jump is governed by the state of ZF prior to the shift—not by the value in AX after the shift.

This is an example of a limit situation, the kind that lurks in the dark recesses of many programming languages. When defining behavior in such situations, it is usually best to consider the zero case as the limit of a sequence of nonzero cases. If the sequence of nonzero cases establishes a pattern, follow it for the zero case. For example, if the flags are set in all cases using a nonzero shift amount, that suggests the zero case should set them too. This is not an issue of CPU efficiency; the practice of setting flags with all shift instructions is simply easier to remember than a rule with an exception. To avoid a problem, set the flags all of the time.

Although this kind of problem may seem to arise only when a shift amount is being computed by adding or subtracting values, in fact it is easy to fall into this trap using constants. Consider a record definition of various bit fields in a word. A common piece of code will isolate bits of information, shift them to low order, and test their value. For example, refer to figure 4.

What is most disturbing about this code is that it works, but for the wrong reason. Again, because CL is 0, the action of the JZ instruction depends upon the flags as set by the AND instruction, not the SHR. An initial test of this code will not reveal any problems, but beware of changing it. Anything inserted between the AND and SHR instructions that sets the ZF flag can cause this sequence to fail. The instructions can be rearranged to place the JZ immediately following the AND, but will this task be easily remembered?

In any case, the user still must deal with how the instructions actually work. To handle this situation properly, he must test CL before executing the shift, or explicitly test the shifted register after the shift, and, in either case, branch accordingly. No special action is required if it is certain CL cannot be 0.

Zero repeats. The other anomaly concerns a repeated string instruction when CX is 0. In the following code,

```
REPNE  SCASB  JE  Found
```

if the branch is taken, does that mean the character was found in AL? As before, the CPU tests CX at the very beginning of the instruction and exits on 0. If CX is 0 to begin with, the entire instruction is skipped—no flags are modified. Again, the action of the succeeding conditional jump is governed by the state of ZF prior to the scan—not by execution of the instruction itself.

Perhaps the CPU should not be faulted for not setting any flags because, after all, it is the SCAS instruction that actually sets the flags and that instruction (correctly) was not executed. Nevertheless, ZF should be cleared to 0 to indicate that the CPU did not find the character for which it was searching—even if it did not look.

The key to this argument is that the proper action when CX is 0 is identical to the action when the item sought is not found. Again, consider the zero case

as the limit of a sequence of nonzero cases. Had the search been executed through a nonzero number of values, none of which matched the one being sought, it would be expected that both ZF and CX would be 0 at the end. As the number of items decreases, the search approaches the zero case. If CX is 0 to begin with, certainly a match cannot be found, so the situations are parallel, and ZF should be cleared to 0 by the instruction.

The above argument is couched in terms of the REPNE prefix, but a dual argument applies for REPE. In that case, ZF should be set to 1 in order to indicate that no characters were unequal to the one in AL. The same argument applies to a repeated CMPS instruction, which also depends upon ZF.

To avoid being caught by this situation, use JCXZ before any repeated SCAS or CMPS for which CX can be 0. JCXZ always branches to the same label as would a conditional jump using the same test as the REPx prefix (that is, JNE for REPNE and JE for REPE).

To an APL programmer faced with defining the behavior of REPNE SCASB, the solution is easy. ZF should be set to the or-reduction of a vector of not-equal comparisons of the value in AL and the CX bytes of memory at ES:DI. If CX is 0, the reduction is performed on an empty vector, and the result (the identity element 0) is well-defined in APL. Similarly, the identity element for the **and** function is 1, which defines the correct behavior for REPE SCAS when CX is 0. This behavior is not a quirk of APL, but a truth of mathematics.

HOW TO TELL A 6 FROM AN 8

The discussion to this point has centered on distinguishing the major categories of CPUs from one another. The remaining distinction is within categories: that is, the 8086 versus the 8088, the V20 versus the V30, and the 80186 versus the 80188. The best known difference is the data path width. The xxxx8 CPUs (and the V20) have an 8-bit data path, the xxxx6 CPUs (and the V30) a 16-bit path. This is difficult to discern via software alone; fortunately, another subtle distinction can be tested.

While each CPU is executing current instructions, other tasks are performed in parallel. Each CPU attempts to optimize its execution by reading on speculation the next few bytes from the instruction stream and bringing them into the CPU. This is called *instruction prefetching* and the place where such instructions are held awaiting execution is called the *prefetch instruction queue*. The concept of instruction prefetching addresses the very common case in which the next instruction to be executed is the one at the next sequential address—assuming no intervening transfer of control takes place. This means an instruction may be read into the CPU before several previous instructions have been executed.

By design, the xxxx6 and xxxx8 CPUs have different prefetch instruction queue lengths: six bytes for the xxxx6 series, four bytes for the xxxx8 series. This difference can be used to determine, via software, which CPU is active. In particular, if a program changes an instruction four bytes ahead and the original instruction is still executed,

By design, the xxxx6 and xxxx8 CPUs have different prefetch instruction queue lengths: six bytes for the xxxx6 series, four bytes for the xxxx8 series.

then it must have been prefetched meaning that the queue length is six (an xxxx6 CPU). If, instead, the new instruction is executed, then the original instruction was not prefetched prior to the change and the queue length must be four (an xxxx8 CPU). (The comments in CPUID.ASM go into further detail about ensuring that the instruction to be modified is actually in a six-byte queue, not a four-byte queue.) This technique is called *self-modifying code*, a method generally frowned upon because it is dependent upon the precise timing of instructions entering and leaving the queue—very tricky business.

NUMERIC COPROCESSORS

Any other chips used with these CPUs are called *coprocessors*, the most common of which are the numeric data processors (NDPs), the 8087 and 80287. These two chips appear almost identical at the software level, except that the 80286/287 signals a new interrupt (processor extension segment overrun interrupt 09H similar to interrupt 0DH). Both chips save the address of each executed instruction (as well as that of operands) in case an exception handler needs to analyze the exceptional instruction. However, as with the divide overflow on 808x/8018x CPUs, an 8087 interrupt handler also is handicapped by not knowing whether the interrupted instruction used any prefixes such as a segment override. This problem was corrected in the 80286/287.

A simpler test exists to distinguish the two NDPs. Contrary to what might be expected, the newer coprocessor ignores two instructions that are recognized by the 8087. The 8087 uses these two instructions, FENI and FDISI, to enable and disable recognition of unmasked exceptions. Because of the way in which unmasked exceptions are recognized in the 80287 (only at WAITs), these instructions are less useful (but not useless) on the 80287. This difference offers a means of identifying the chips: if the NDP is present and changes state via an FDISI (or FENI), it is an 8087; otherwise it is an 80287.

The test for the *presence* of an NDP changed when the 80287 came out. In particular, the control word after an FNINIT is different: 03FFH for an 8087, 037FH for an 80287 (the 8087 IEM bit is undefined and 0 in the 80287). Also, some PC/ATs without an 80287 do not completely ignore an FNSTCW. Several ATs tested store 3ED9H into the word operand of the instruction instead of ignoring it. Intel recommends comparing the high-order byte of the result of FNSTCW with 03H. If equal, an NDP is present, otherwise it is not. IBM recommends testing bit 1 in AX after executing INT 11H (equipment determination). This bit is set automatically by the BIOS code on an AT and by the user via a system board switch on other machines. On pre-AT systems the switch controls whether or not unmasked NDP exceptions are enabled; it has no effect otherwise. If a piece of code signals such exceptions, be sure to check the equipment flags. CPUID.COM tests and reports on any mismatch.

These chips are not without their problems. For example, their design is based upon an early draft (number 8) of IEEE 754 Standard for Binary Floating-Point Arithmetic. Although later drafts changed the specs, the design of the NDP chips had already been set. The differences are extremely subtle, some giving the appearance of being off by one unit in the last place in very rare circumstances. For example, in both single- and double-precision formats, the following

```
half_infinity + half_infinity
```

is computed as would be expected when the rounding mode is down (toward negative infinity), but not when it

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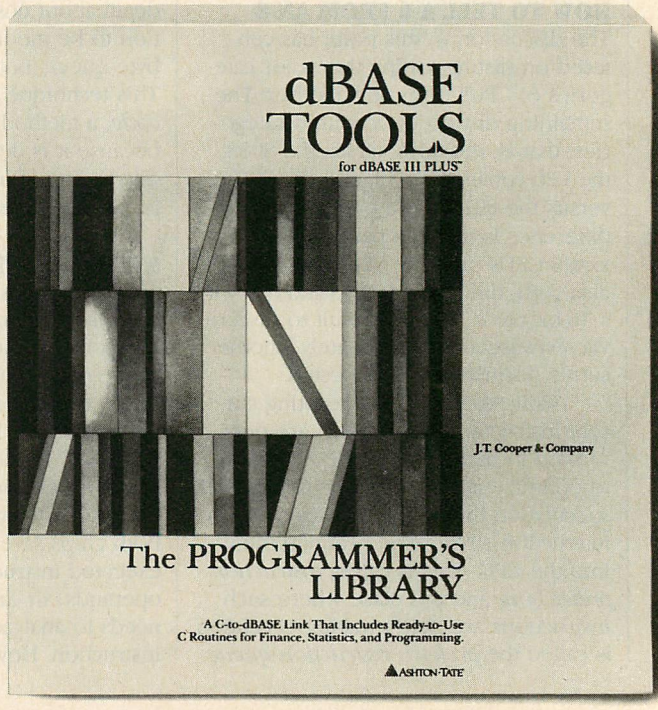
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is chop (toward 0). When adding two positive numbers most users would not expect those two rounding modes to produce different results, but that is what Draft 8 prescribed and the chips correctly implement it. (The value **half_infinity** is infinity decremented by one in the exponent.) Other differences are equally subtle, and are documented in the *iAPX 286 Programmer's Reference Manual*, Numeric Supplement, Appendix C "Implementing the IEEE P754 Standard" (Intel Corporation, 1985). In spite of these differences, the chips operate correctly according to the specs; the specs, though, are out of date with respect to accepted standards.

CHIPS AHEAD

The CPUID.ASM program distinguishes all of the Intel and NEC CPUs used in the IBM PC family and compatibles: the 8086, 8088, V20, V30, 80186, 80188, 80286, 8087, and 80287. The assembled test program CPUID (which is available in both source code and compiled form on PCTECHline) is organized as a .COM file ready to run as is. The main procedure it calls is easily separated as a subroutine callable from other procedures. In this latter form, it is useful for those circumstances when it is necessary to execute CPU-specific code, such as in debuggers, interrupt handlers, and other system-level code.

This tour of the Intel and NEC lines of 16-bit CPUs concentrated on differences in the way each executes the basic (8086/88) instruction set. Although these differences are important mainly to professional software developers who must juggle the multiple environments in which their programs might run, anyone programming in assembly language can run afoul of them. This discussion should, however, help users to avoid almost all of the traps; other differences may come to light as programmers continue to develop software among these chips.

REFERENCES

iAPX 86,88 User's Manual, Santa Clara, CA: Intel Corporation, 1981.

Morse, Stephen P., *The 8086/8088 Primer* (second edition), Rochelle Park, NJ: Hayden Book Company, Inc., 1982.

Speaking Softly—A Newsletter to Independent Software Vendors (vol. 2, no. 2), Santa Clara, CA: Intel Corporation, 1985.

Bob Smith is president of Qualitas, Inc., the maker of TallScreen. He is an active member of the Capital PC User Group, Inc.

LISTING 1: CPUID.ASM

```
        title   CPUID -- Determine CPU & NDP Type
        page    58,122
        name    CPUID

COMMENT|

CPUID uniquely identifies each NEC & Intel CPU & NDP.

Notes on Program Structure
   This program uses four segments, two classes, and one group.  It
demonstrates a useful technique for programmers who generate .COM
programs.  In particular, it shows how to use segment classes to
re-order segments, and how to eliminate the linker's warning message
about the absence of a stack segment.
   The correspondence between segments and classes is as follows:

        Segment         Class
        -------         -----
        STACK           prog
        DATA            data
        MDATA           data
        CODE            prog

   The segments appear in the above order in the program source to
avoid forward references in the CODE segment to labels in the
DATA/MDATA segments.  However, because the STACK segment appears first
in the file, it and all segments in the same class are made contiguous
by the linker.  Thus they precede the DATA/MDATA segments in the
resulting .COM file because the latter are in a different class.  In
this manner, although DATA and MDATA precede CODE in the source file,
their order is swapped in the .COM file.  That way there is no need
for an initial skip over the data areas to get to the CODE segment.
As a side benefit, declaring a STACK segment (as the first segment in
the source) also eliminates the linker's warning about that segment
being missing.  Finally, all segments are declared to be in the same
group so the linker can properly resolve offsets.
   Note that if you re-assemble the code for any reason, it is
important to use an assembler later than the IBM version 1.0.  That
version has a number of bugs including an annoying habit of
alphabetizing segment names in the .OBJ file.  If you use IBM MASM
2.0, be sure to specify /S to order the segments properly.
   If the program reports results at variance with your knowledge of
the system, please contact the author.

Environments tested in:

                CPU Speed
  System          in MHz        CPU             NDP
  ------------------------------------------------
  IBM PC AT         6         Intel 80286     Intel 80287
  IBM PC AT         9         Intel 80286     Intel 80287
  IBM PC AT         6         Intel 80286     none
  IBM PC AT         8.5       Intel 80286     none
  IBM PC            4.77      Intel 8088      Intel 8087-3
  IBM PC            4.77      Intel 8088*     Intel 8087-3
  IBM PC XT         4.77      Intel 8088      none
  IBM PC XT         4.77      Intel 8088      Intel 8087-3
  COMPAQ            4.77      Intel 8088      none
  COMPAQ            4.77      NEC V20         none
  AT&T PC 6300      8         Intel 8086      Intel 8087-2
  AT&T PC 6300      8         NEC V30         Intel 8087-2
  TANDY 2000        8         Intel 80186     none

  * = faulty CPU

Program structure:
  Group PGROUP:
  Stack   segment STACK, byte-aligned, stack,  class 'prog'
  Program segment CODE,  byte-aligned, public, class 'prog'
  Data    segment DATA,  byte-aligned, public, class 'data'
  Data    segment MDATA, byte-aligned, public, class 'data'

Assembly requirements:
  Use MASM 1.25 or later.
  With IBM's MASM 2.0 only, use /S to avoid
    alphabetizing the segment names.
  Use /r option to generate real NDP code.
  MASM CPUID/r;                 to convert .ASM to .OBJ
  LINK CPUID;                   to convert .OBJ to .EXE
  EXE2BIN CPUID CPUID.COM       to convert .EXE to .COM
  ERASE CPUID.EXE               to avoid executing .EXE

  Note that the linker doesn't warn about a missing stack segment.

Original code by:       Bob Smith           May 1985
                        Qualitas, Inc.
                        8314 Thoreau Dr.
                        Bethesda MD 20817

  Arthur Zachai suggested the technique to distinguish within the 808x
  and 8018x families by exploiting the difference in the length of
  their pre-fetch instruction queues.
|

        subttl  Structures, Records, Equates, & Macros
        page
ARG_STR struc

        dw      ?               ; Caller's BP
ARG_OFF dw      ?               ; Caller's offset
ARG_SEG dw      ?               ;         segment
```

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```
ARG_FLG  dw      ?              ;          flags

ARG_STR  ends

; Record to define bits in the CPU's & NDP's flags' registers
CPUFLAGS record  R0:1,NT:1,IOPL:2,OF:1,DF:1,IF:1,TF:1,SF:1,ZF:1,R1:1,
AF:1,R2:1,PF:1,R3:1,CF:1
NDPFLAGS record  R4:3,IC:1,RC:2,PC:2,IEM:1,R5:1,PM:1,UM:1,OM:1,ZM:1,
DM:1,IM:1

COMMENT|
FLG_PIQL         Pre-fetch instruction queue length, 0 => 4-byte,
                                                    1 => 6-byte
FLG_08           Intel 808x
FLG_NEC          NEC V20 or V30
FLG_18           Intel 8018x
FLG_28           Intel 8028x
FLG_87           Intel 8087
FLG_287          Intel 80287

FLG_CERR         Faulty CPU
FLG_NERR         Faulty NDP switch setting
|
FLG      record  RSVD:9,FLG_NERR:1,FLG_CERR:1,FLG_NDP:2,FLG_CPU:3

; CPU-related flags
FLG_PIQL equ     001b shl FLG_CPU
FLG_08   equ     000b shl FLG_CPU
FLG_NEC  equ     010b shl FLG_CPU
FLG_18   equ     100b shl FLG_CPU
FLG_28   equ     110b shl FLG_CPU

FLG_8088 equ     FLG_08
FLG_8086 equ     FLG_08 or FLG_PIQL
FLG_V20  equ     FLG_NEC
FLG_V30  equ     FLG_NEC or FLG_PIQL
FLG_80188 equ    FLG_18
FLG_80186 equ    FLG_18 or FLG_PIQL
FLG_80286 equ    FLG_28 or FLG_PIQL

; NDP-related flags
;                00b shl FLG_NDP        Not present
FLG_87   equ     01b shl FLG_NDP
FLG_287  equ     10b shl FLG_NDP
BEL      equ     07h
LF       equ     0Ah
CR       equ     0Dh
EOS      equ     '$'

POPFF    macro
         local   L1,L2
         jmp     short L2       ; Skip over IRET
L1:
         iret                   ; Pop the CS & IP pushed below along
                                ; w. the flags, our original purpose
L2:
         push    cs             ; Prepare for IRET by pushing CS
         call    L1             ; Push IP, jump to IRET

         endm                   ; POPFF macro

TAB      macro   TYP

         push    bx             ; Save for a moment
         and     bx,mask FLG_&TYP ; Isolate flags
         mov     cl,FLG_&TYP    ; Shift amount
         shr     bx,cl          ; Shift to low-order
         shl     bx,1           ; Times two to index table of words
         mov     dx,TYP&MSG_TAB[bx] ; DS:DX ==> descriptive message
         pop     bx             ; Restore

         mov     ah,09h         ; Function code to display string
         int     21h            ; Request DOS service

         endm                   ; TAB macro
         page
INT_VEC  segment at 0           ; Start INT_VEC segment

         dd      ?              ; Pointer to INT 00h
INT01_OFF dw     ?              ; Pointer to INT 01h
INT01_SEG dw     ?

INT_VEC  ends                   ; End INT_VEC segment

PGROUP   group   STACK,CODE,DATA,MDATA

; The following segment both positions class 'prog' segments lower in
; memory than others so the first byte of the resulting .COM file is
; in the CODE segment, as well as satisfies the LINKer's need to have
; a stack segment.

STACK    segment byte stack 'prog' ; Start STACK segment
STACK    ends                   ; End STACK segment

I11_REC  record  I11_PRN:2,I11_RSV1:2,I11_COM:3,I11_RSV2:1,I11_DISK:2,
I11_VID:2,I11_RSV3:2,I11_NDP:1,I11_IPL:1

DATA     segment byte public 'data' ; Start DATA segment
         assume  ds:PGROUP

OLDINT01_VEC label dword  ; Save area for original INT 01h handler
OLDINT01_OFF dw  ?
OLDINT01_SEG dw  ?

NDP_CW   label   word           ; Save area for NDP control word
         db      ?
NDP_CW_HI db     0              ; High byte of control word
NDP_ENV  dw      7 dup (?)      ; Save area for NDP environment

DATA     ends                   ; End DATA segment
         subttl  Message Data Area
         page
MDATA    segment byte public 'data' ; Start MDATA segment
         assume  ds:PGROUP

MSG_START db     'CPUID    -- Version 1.0'
          db     CR,LF,EOS
MSG_8088 db      'CPU is an Intel 8088.',CR,LF,EOS
MSG_8086 db      'CPU is an Intel 8086.',CR,LF,EOS
MSG_V20  db      'CPU is an NEC V20.',CR,LF,EOS
MSG_V30  db      'CPU is an NEC V30.',CR,LF,EOS
MSG_80188 db     'CPU is an Intel 80188.',CR,LF,EOS
MSG_80186 db     'CPU is an Intel 80186.',CR,LF,EOS
MSG_UNK  db      'CPU is a maverick -- 80288??',CR,LF,EOS
MSG_80286 db     'CPU is an Intel 80286.',CR,LF,EOS

CPUMSG_TAB label word
         dw      PGROUP:MSG_8088        ; 000 = Intel 8088
         dw      PGROUP:MSG_8086        ; 001 = Intel 8086
         dw      PGROUP:MSG_V20         ; 010 = NEC V20
         dw      PGROUP:MSG_V30         ; 011 = NEC V30
         dw      PGROUP:MSG_80188       ; 100 = Intel 80188
         dw      PGROUP:MSG_80186       ; 101 = Intel 80186
         dw      PGROUP:MSG_UNK         ; 110 = ?
         dw      PGROUP:MSG_80286       ; 111 = Intel 80286

NDPMSG_TAB label word
         dw      PGROUP:MSG_NDPX        ; 00 = No NDP
         dw      PGROUP:MSG_8087        ; 01 = Intel 8087
         dw      PGROUP:MSG_80287       ; 10 = Intel 80287

MSG_NDPX db      'NDP is not present.',CR,LF,EOS
MSG_8087 db      'NDP is an Intel 8087.',CR,LF,EOS
MSG_80287 db     'NDP is an Intel 80287.',CR,LF,EOS

CERRMSG_TAB label word
         dw      PGROUP:MSG_CPUOK       ; 0 = CPU healthy
         dw      PGROUP:MSG_CPUBAD      ; 1 = CPU faulty

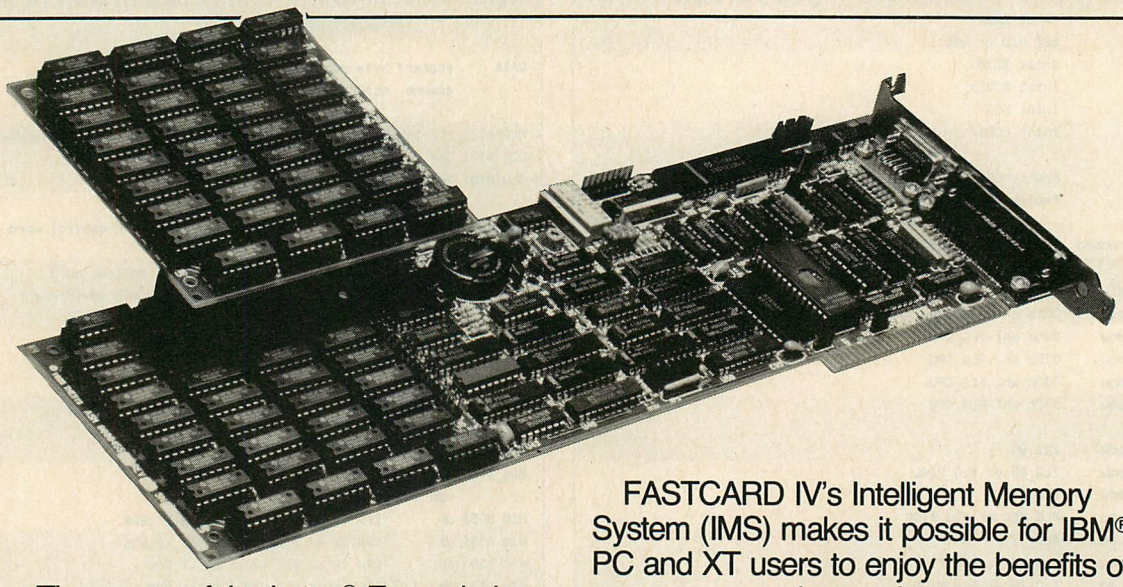
MSG_CPUOK db     'CPU appears to be healthy.',CR,LF,EOS
MSG_CPUBAD label byte
db BEL,'*** CPU incorrectly allows interrupts'
db 'after a change to SS ***',CR,LF
db 'It should be replaced with a more recent'
db 'version as it could crash the',CR,LF
db 'system at seemingly random times.',CR,LF,EOS

NERRMSG_TAB label word
         dw      PGROUP:MSG_NDPSWOK   ; 0 = NDP switch set correctly
         dw      PGROUP:MSG_NDPSWERR  ; 1 = NDP switch set incorrectly

MSG_NDPSWOK db   EOS                  ; No message
```

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```
MSG_NDPSWERR label  byte
db '*** Although there is an NDP installed'
db 'on this system, the corresponding',CR,LF
db 'system board switch is not properly set.  '
db 'To correct this, flip switch 2 of',CR,LF
db 'switch block 1 on the system board.',CR,LF,EOS

MDATA   ends                    ; End MDATA segment
        subttl  Main Routine
        page
CODE    segment byte public 'prog' ; Start CODE segment
        assume  cs:PGROUP,ds:PGROUP,es:PGROUP
        org     100h            ; Skip over PSP
INITIAL proc    near
        mov     dx,offset ds:MSG_START ; Starting message
        mov     ah,09h          ; Function code to display string
        int     21h             ; Request DOS service

        call    CPUID           ; Check the CPU's identity

        TAB     CPU             ; Display CPU results
        TAB     NDP             ; Display NDP results
        TAB     CERR            ; Display CPU ERR results
        TAB     NERR            ; Display NDP ERR results

        ret                     ; Return to DOS

INITIAL endp                    ; End INITIAL procedure
        subttl  CPUID Procedure
        page
CPUID   proc    near            ; Start CPUID procedure
        assume  cs:PGROUP,ds:PGROUP,es:PGROUP
COMMENT|
This procedure determines the type of CPU and NDP (if any) in use.
The possibilities include:
Intel 8086
Intel 8088
NEC   V20
NEC   V30
Intel 80186
Intel 80188
Intel 80286
Intel 8087
Intel 80287

   Also checked is whether or not the CPU allows interrupts after
changing the SS segment register.  If the CPU does, it is faulty and
should be replaced.
   Further, if an NDP is installed, non-AT machines should have a
system board switch set. Such a discrepancy is reported.
   On exit, BX contains flag settings (as defined in FLG record) which
the caller can check.  For example, to test for an Intel 80286, use

        and     bx,mask FLAG_CPU
        cmp     bx,FLG_80286
        je      ITSA286
|
        irp     XX,<ax,cx,di,ds,es> ; Save registers
        push    XX
        endm

; Test for 80286 -- this CPU executes PUSH SP by first storing SP on
; stack, then decrementing it.  Earlier CPUs decrement, THEN store.

        mov     bx,FLG_28       ; Assume it's a 286
        push    sp              ; Only 286 pushes pre-push SP
        pop     ax              ; Get it back
        cmp     ax,sp           ; Check for same
        je      CHECK_PIQL      ; They are, so it's a 286

; Test for 80186/80188 -- 18x and 286 CPUs mask shift/rotate
; operations mod 32; earlier CPUs use all 8 bits of CL.

        mov     bx,FLG_18       ; Assume it's an 8018x
        mov     cl,32+1         ; 18x masks shift counts mod 32
                                ; Note we can't use just 32 in CL
        mov     al,0FFh         ; Start with all bits set

        shl     al,cl           ; Shift one position if 18x
        jnz     CHECK_PIQL      ; Some bits still on,
                                ; so it's a 18x, check PIQL

        mov     bx,FLG_NEC      ; Assume it's an NEC V-series CPU
        call    CHECK_NEC       ; See if it's an NEC chip
        jcxz    CHECK_PIQL      ; Good guess, check PIQL

        mov     bx,FLG_08       ; It's an 808x
        subttl  Check Length Of Pre-fetch Instruction Queue
        page
COMMENT|
Check the length of the pre-fetch instruction queue (PIQ).
xxxx6 CPUs have a PIQ length of 6 bytes,
xxxx8 CPUs   "     "     "     4   "

Self-modifying code is used to distinguish the two PIQ lengths.
|
CHECK_PIQL:
        call    PIQL_SUB        ; Handled via subroutine
        jcxz    CHECK_ERR       ; If CX is 0, INC was not executed,
                                ; hence PIQ length is 4
        or      bx,FLG_PIQL     ; PIQ length is 6
        subttl  Check For Allowing Interrupts After POP SS
        page
; Test for faulty chip (allows interrupts after change to SS register)
CHECK_ERR:
        xor     ax,ax           ; Prepare to address
                                ; interrupt vector segment
        mov     ds,ax           ; DS points to segment 0
        assume  ds:INT_VEC      ; Tell the assembler

        cli                     ; Nobody move while we swap

        mov     ax,offset cs:INT01 ; Point to our own handler
        xchg    ax,INT01_OFF    ; Get and swap offset
        mov     OLDINT01_OFF,ax ; Save to restore later

        mov     ax,cs           ; Our handler's segment
        xchg    ax,INT01_SEG    ; Get and swap segment
        mov     OLDINT01_SEG,ax ; Save to restore later

; Note we continue with interrupts disabled to avoid
; an external interrupt occurring during this test.
        mov     cx,1            ; Initialize a register
        push    ss              ; Save SS to store back into itself
        pushf                   ; Move flags
        pop     ax              ; ...into AX
        or      ax,mask TF      ; Set trap flag
        push    ax              ; Place onto stack
        POPFF                   ; ...and then into effect
                                ; Some CPUs effect the trap flag
                                ;   immediately, some
                                ;   wait one instruction
        nop                     ; Allow interrupt to take effect
POST_NOP:
        pop     ss              ; Change the stack segment register
                                ;   (to itself)
        dec     cx              ; Normal CPUs execute this instruction
                                ;   before recognizing the single-step
                                ;   interrupt
        hlt                     ; We never get here
INT01:
; Note IF=TF=0
; If we're stopped at or before POST_NOP, continue on

        push    bp              ; Prepare to address the stack
        mov     bp,sp           ; Hello, Mr. Stack

        cmp     [bp].ARG_OFF,offset cs:POST_NOP ; Check offset
        pop     bp              ; Restore
        ja      INT01_DONE      ; We're done

        iret                    ; Return to caller
INT01_DONE:
; Restore old INT 01h handler
        les     ax,OLDINT01_VEC ; ES:AX ==> old INT 01h handler
        assume  es:nothing      ; Tell the assembler
        mov     INT01_OFF,ax    ; Restore offset
        mov     INT01_SEG,es    ; ...and segment
        sti                     ; Allow interrupts again (IF=1)

        add     sp,3*2          ; Strip IP, CS, and Flags from stack

        push    cs              ; Setup DS for code below
```

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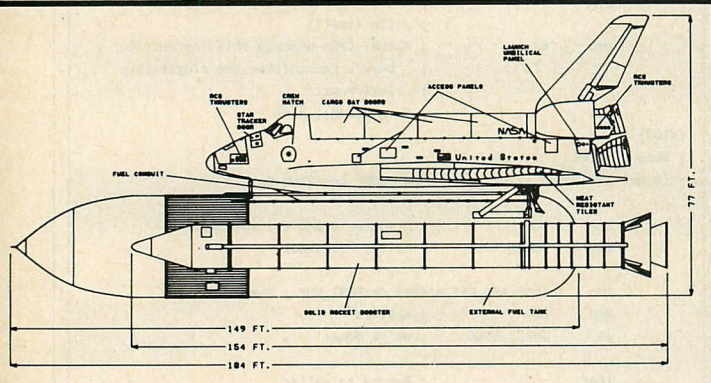
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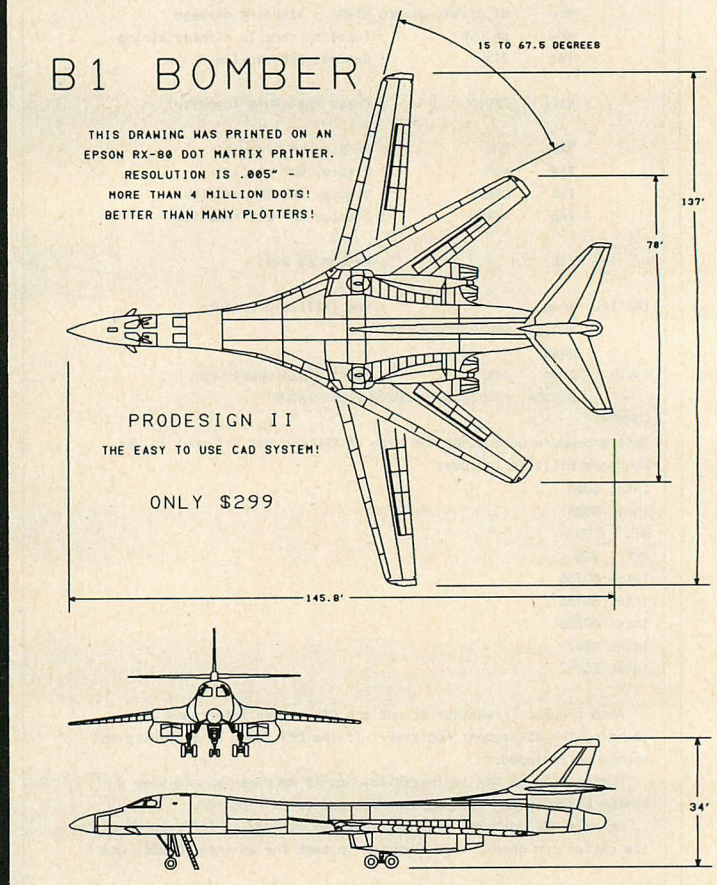
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```
        pop     ds
        assume  ds:PGROUP       ; Tell the assembler

        jcxz    CHECK_NDP       ; If CX is 0, the DEC CX was executed,
                                ; and the CPU is OK
        or      bx,mask FLG_CERR ; It's a faulty chip
        subttl  Check For Numeric Data Processor
        page
COMMENT|
   Test for a Numeric Data Processor -- Intel 8087 or 80287.  The
technique used is passive -- it leaves the NDP in the same state in
which it is found.
|
CHECK_NDP:
        cli                     ; Protect FNSTENV
        fnstenv NDP_ENV         ; If NDP present, save
                                ;    current environment,
                                ;    otherwise, this instruction
                                ;    is ignored
        mov     cx,50/7         ; Cycle this many times
        loop    $               ; Wait for result to be stored
        sti                     ; Allow interrupts
        fninit                  ; Initialize processor to known state
        jmp     short $+2       ; Wait for initialization

        fnstcw  NDP_CW          ; Save control word
        jmp     short $+2       ; Wait for result to be stored
        jmp     short $+2
        cmp     NDP_CW_HI,03h   ; Check for NDP initial control word
        jne     CPUID_EXIT      ; No NDP installed
        int     11h             ; Get equipment flags into AX
        test    ax,mask I11_NDP ; Check NDP-installed bit
        jnz     CHECK_NDP1      ; It's correctly set
        or      bx,mask FLG_NERR ; Mark as in error
CHECK_NDP1:
        and     NDP_CW,not mask IEM ; Enable interrupts
                                ;    (IEM=0, 8087 only)
        fldcw   NDP_CW          ; Reload control word
        fdisi                   ; Disable interrupts (IEM=1) on 8087,
                                ; ignored by 80287
        fstcw   NDP_CW          ; Save control word
        fldenv  NDP_ENV         ; Restore original NDP environment
                                ; No need to wait
                                ;   for environment to be loaded
        test    NDP_CW,mask IEM ; Check Interrupt Enable Mask
                                ;    (8087 only)
        jnz     CPUID_8087      ; It changed, hence NDP is an 8087
        or      bx,FLG_287      ; NDP is an 80287
        jmp     short CPUID_EXIT ; Exit with flags in BX
CPUID_8087:
        or      bx,FLG_87       ; NDP is an 8087
CPUID_EXIT:
        irp     XX,<es,ds,di,cx,ax> ; Restore registers
        pop     XX
        endm
        assume  ds:nothing,es:nothing
        ret                     ; Return to caller

CPUID   endp                    ; End CPUID procedure
        subttl  Check For NEC V20/V30
        page
CHECK_NEC proc  near

COMMENT|
   The NEC V20/V30 CPUs are very compatible with the Intel 8088/8086.
The only point of "incompatiblity" is that they do not contain a bug
found in the Intel CPUs.  Specifically, the NEC CPUs correctly restart
an interrupted multi-prefix string instruction at the start of the
instruction.  The Intel CPUs incorrectly restart it in the middle of
the instruction.  This routine tests for that situation by executing
such an instruction for a sufficiently long period of time for a timer
interrupt to occur.  If at the end of the instruction, CX is zero,
it must be an NEC CPU; if not, it's an Intel CPU.
   Note that we're counting on the timer interrupt to do its thing
every 18.2 times per second.
   Here's a worst case analysis:  An Intel 8088/8086 executes 65535
iterations of LODSB ES:[SI] in 2+9+13*65535 = 851,966 clock ticks.  If
the Intel 8088/8086 is running at 10 MHz, each clock tick is 100
nanoseconds, hence the entire operation takes 85 milliseconds.  If the
timer is running at normal speed, it interrupts the CPU every 55ms
and so should interrupt the repeated string instruction at least once.
|
        mov     cx,0FFFFh       ; Move a lot of data
        sti                     ; Ensure timer enabled

; Execute multi-prefix instruction.  Note that the value of ES as
; well as the direction flag setting is irrelevant.

        push    ax              ; Save registers
        push    si
    rep lods    byte ptr es:[si]
        pop     si              ; Restore
        pop     ax

; On exit, if CX is zero, it's an NEC CPU, otherwise it's an Intel CPU
        ret                     ; Return to caller

CHECK_NEC endp
        subttl  Pre-fetch Instruction Queue Subroutine
        page
PIQL_SUB proc   near

COMMENT|
   This subroutine discerns the length of the CPU's pre-fetch
instruction queue (PIQ).
   The technique used is to first ensure that the PIQ is full, then
change an instruction which should be in a 6-byte PIQ but not in a
4-byte PIQ.  Then, if the original instruction is executed, the PIQ
is 6 bytes long; if the new instruction is executed, PIQ length is 4.
   We ensure the PIQ is full by executing an instruction which takes
long enough so that the Bus Interface Unit (BIU) can fill the PIQ
while the instruction is executing.
   Specifically, for all but the last STOSB, we're simply marking time
waiting for the BIU to fill the PIQ.  The last STOSB actually changes
the instruction.  By that time, the original instruction should be in
a six-byte PIQ but not a four-byte PIQ.
|
        assume  cs:PGROUP,es:PGROUP

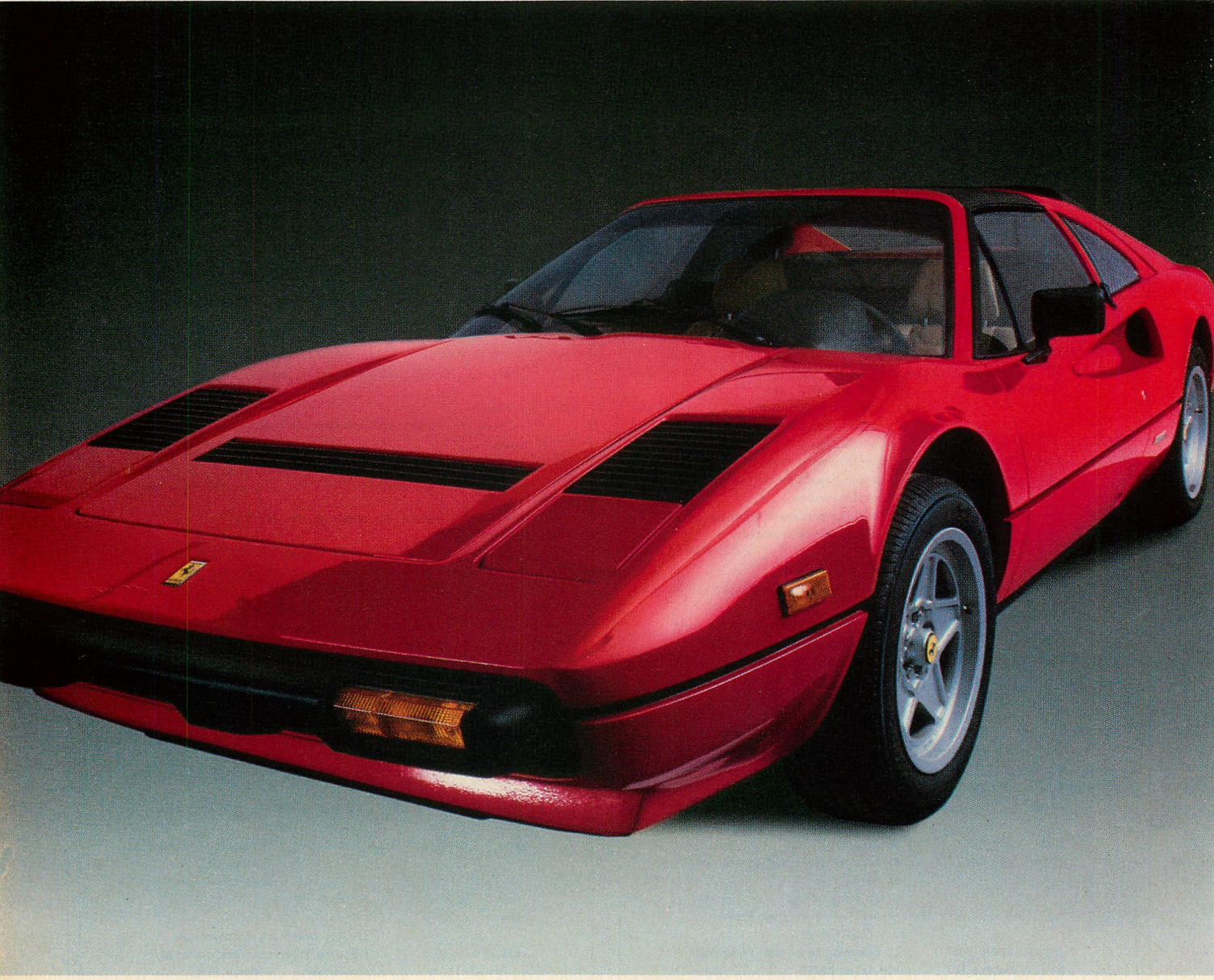
@REP    equ     3               ; Repeat the store this many times
        std                     ; Store backwards
        mov     di,offset es:LAB_INC+@REP-1 ; Change the instructions
                                            ;   at ES:DI
                                            ; and preceding
        mov     al,ds:LAB_STI   ; Change to a STI
        mov     cx,@REP         ; Give the BIU time
                                ;    to pre-fetch instructions
        cli                     ; Ensure interrupts are disabled,
                                ;    otherwise a timer tick
                                ;    could change the PIQ filling
    rep stosb           ; Change the instruction
                        ; During execution of this instruction the BIU
                        ; is refilling the PIQ.  The current
                        ; instruction is no longer in the PIQ.
                        ; Note at end, CX is 0
; The PIQ begins filling here
        cld                     ; Restore direction flag
        nop                     ; PIQ fillers
        nop
        nop

; The following instruction is beyond a four-byte-PIQ CPU's reach,
; but within that of a six-byte-PIQ CPU.

LAB_INC label   byte
        inc     cx              ; Executed only if PIQ length is 6

LAB_STI label   byte
        rept    @REP-1
        sti                     ;; Restore interrupts
        endm
        ret                     ; Return to caller
        assume  ds:nothing,es:nothing
PIQL_SUB endp                   ; End PIQL_SUB procedure

CODE    ends                    ; End CODE segment
        if1
%OUT Pass 1 complete
        else
%OUT Pass 2 complete
        endif
        end     INITIAL         ; End CPUID module
```



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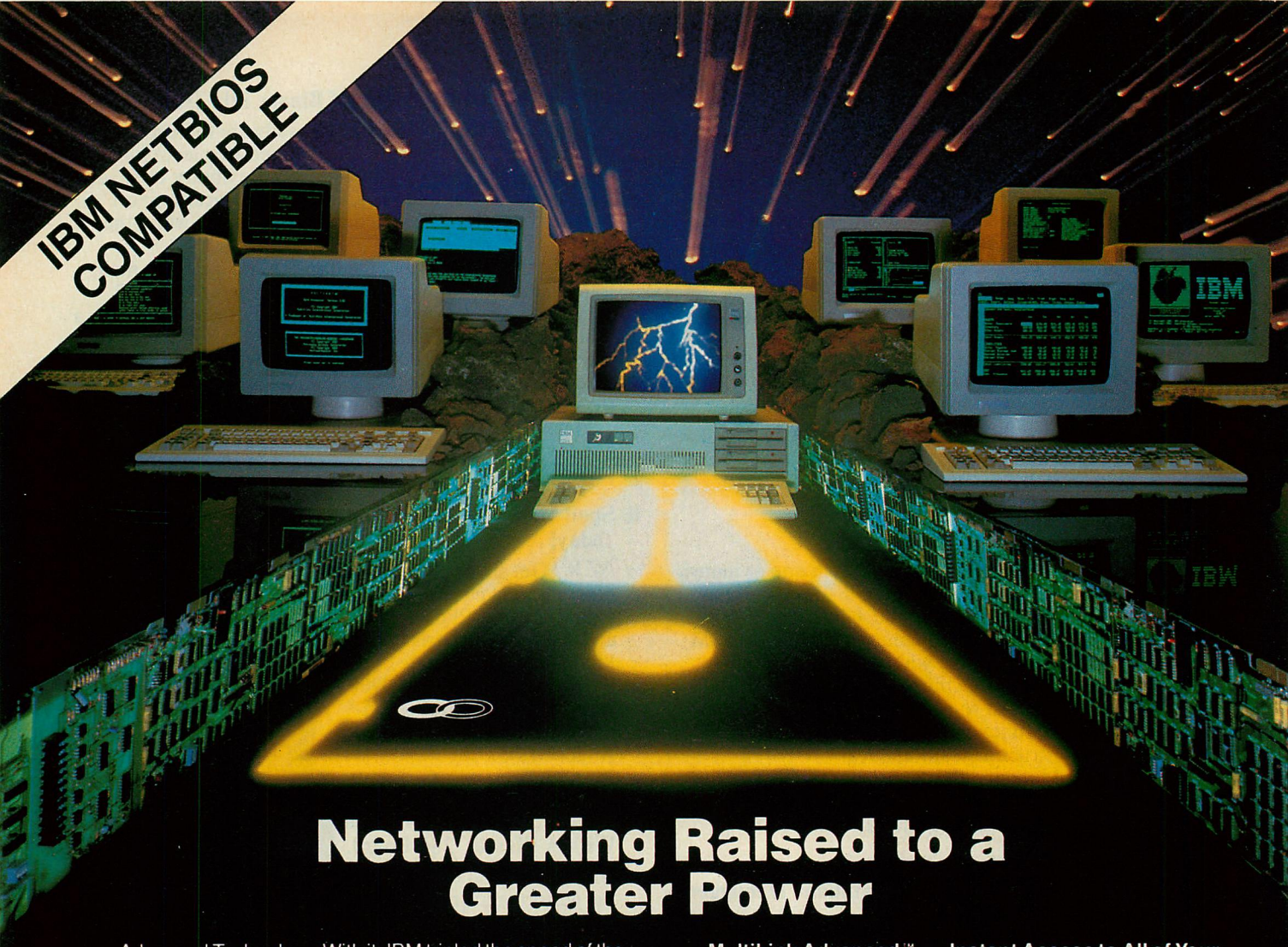
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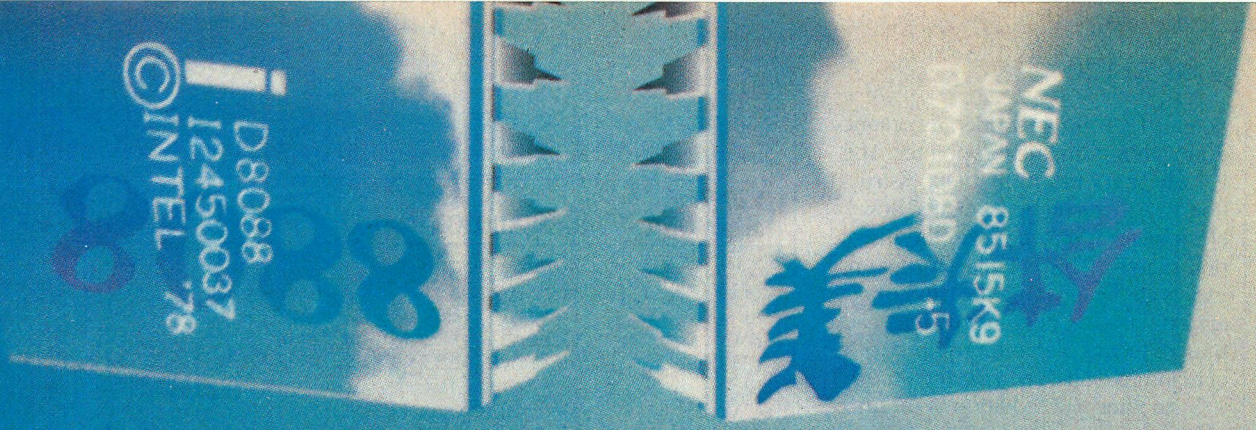
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8088 vs 美式拾*

Intel's 8088 chip and NEC's V20 enhancement are in competition; the V20 may offer more than just an improvement in overall performance.

JUAN JIMENEZ and STEVE KING

An ongoing goal in the microcomputer industry is to make faster, better, less power-hungry processors while retaining compatibility with older machines. (See "Chips in Transition," this issue, p. 56.) Nippon Electric Corporation (NEC) has achieved this goal in designing its improved versions of Intel's 8088 and 8086 CPUs. NEC's two new 16-bit processors, the 70108D and 70116D, are known in this country as the V20 and V30. These devices replace the 8088 and 8086, respectively, and are available in both 5- and 8-MHz speeds. NEC's devices offer more than just high performance and compatibility. The company has added new instructions, along with the remarkable option of an emulation mode for Intel's first single-chip 8-bit CPU, the venerable 8080. This article explores the NEC V20 and V30 and the implications for developing code for the 8088, 8086, 80188, and 80186.

The V20 and V30 are CMOS devices, a direct indication of their lower power consumption (300 mw in active mode); thus, they produce less heat to dissipate inside the system. Intel's 8088 and 8086 both dispel 1.7 watts while running, creating considerably more heat. Their lower power consumption reduces the demands on a system's supply. Both of the chips also offer standby mode. While a device is in this mode, it consumes one-tenth the power required in full active mode, making it ideal for use in lap-top or portable computers where battery life is a factor. Interrupts continue to be recognized while in standby; once identified, the interrupt request "awakens" the sleeping V20 to service the interrupt.

The most obvious differences between the V20/30 and the Intel chips are new registers and different names for old registers (see table 1). Table 2 shows how the NEC V20/30 program status word (flag register) is further subdivided into bit field definitions.

Architecturally the most apparent change is a dual internal bus (see figure 1) versus the single internal bus that is included on the 8088/86. Now that manufacturers have learned to effect higher density integration, it has become relatively inexpensive to add more power to existing LSI devices, as NEC has done with the V20/30. These chips now execute internal data transmission in parallel, with both source and destination data traversing the full 16-bit-width buses at the same time, thereby decreasing instruction execution time.

The 8088/86 calculate effective addresses using both hardware and microcode; this normally takes from 5 to 12 clock cycles. NEC has enhanced this part of the microprocessor and replaced the microcode with a dedicated hardware section that performs effective address calculations of any type in two clock cycles. Depending on the operation, V20/30 address calculation throughput is increased in this area from 150 to 600 percent.

NEC also has added a completely new item to the design—a prefetch

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*The kanji characters for V20.

pointer (PFP)—that works in conjunction with the instruction pointer. The PFP always points to the next instruction to be executed, no matter how close or far it may be from the instruction pointer. This enhances program execution by allowing the device to always have the next instruction ready, thus reducing the time required to execute jumps, calls, returns, and so on.

Another NEC addition is three 16-bit temporary registers that are used strictly for multiplication, division, shift, and rotation operation. These registers are *not* accessible by the programmer or the application program; they are for internal use only. The significance of these new registers is not apparent until benchmarks are performed, particularly benchmarks using math-intensive software. Tests run on a Compaq Deskpro (which normally uses an 8086) produced rather impressive results when the 8086 was replaced by a V30. The benchmark timings for this substitution as well as for the replacement of an 8088 by a V20 in a Compaq Portable are listed in table 3.

In that table, Sysinfo is a system performance measurement tool that is part of the Norton Utilities. The algorithm it uses has not been made public, but it is designed so that a standard IBM PC returns a value of 1.0. Faster machines return a larger figure, slower machines a smaller one. The HILB demo is a program that originated in Alan R. Miller's book *Pascal Programs for Scientists and Engineers* (Sybex, 1981) and is supplied with every copy of Turbo-87 Pascal; it is not reproduced here. This program uses the Gauss-Jordan method of matrix inversion to invert and solve a 10-by-10 matrix. MULDIV.PAS, listing 1, is a simple multiplication and division benchmark that performs ten thousand real number multiplications and divisions. Listing 2 (SIEVE.PAS) is the classic Sieve of Eratosthenes for prime numbers.

In addition to the three temporary registers, the NEC devices have a Loop Counter that counts the number of loops for a primitive block transfer instruction and the number of shifts that will be performed for a multiple bit-shift/rotation instruction. This counter works very closely with the three temporary registers and is a major factor in processing speed improvement.

THE V20/30 INSTRUCTION SET

The V20 and V30 implement 101 machine instructions, including both the 8088/86 and 80188/86 instruction sets. The V20/30 set also contains several new instructions that provide additional power and flexibility. An 8080 instruction set is also available (and is discussed below).

Instruction mnemonics are considered worthy of copyright. As a result, NEC has created a new suite of mnemonics for the traditional 86-family instructions, which makes the NEC documentation sometimes difficult to follow. A perusal of the binary patterns for the instruction set will verify that all 86-family instructions are present, if oddly named. The enhanced instructions (which correspond to the Intel 80186 and 80188-specific instructions) available on the V20 and V30 are listed here.

Enhanced stack operation. This first instruction, PUSH imm, allows immediate data to be pushed onto the stack. The following instructions allow the programmer to push the contents of all

TABLE 1: *V20/30 versus 8088/86 Register Nomenclature*

V20/30 MNEMONIC	DESCRIPTION	8088/86 EQUIVALENT
AW	Accumulator (16-bit)	AX
AH	High byte of AW	AH
AL	Low byte of AW	AL
BW	General register (16-bit)	BX
BH	High byte of BW	BH
BL	Low byte of BW	BL
CW	General register (16-bit)	CX
CH	High byte of CW	CH
CL	Low byte of CW	CL
DW	General register (16-bit)	DX
DH	High byte of DW	DH
DL	Low byte of DW	DL
PC	Program counter	IP
PS	Program segment register	CS
SS	Stack segment register	SS
DS0	Data segment 0	DS
DS1	Data segment 1	ES
PFP	Prefetch pointer	No equivalent
SP	Stack pointer	SP
BP	Base pointer	BP
IX	Index register (source)	SI
IY	Index register (destination)	DI
TA	Temporary register A (internal)	No equivalent
TB	Temporary register B (internal)	No equivalent
TC	Temporary register C (internal)	No equivalent
PSW	Program status word	Flag register

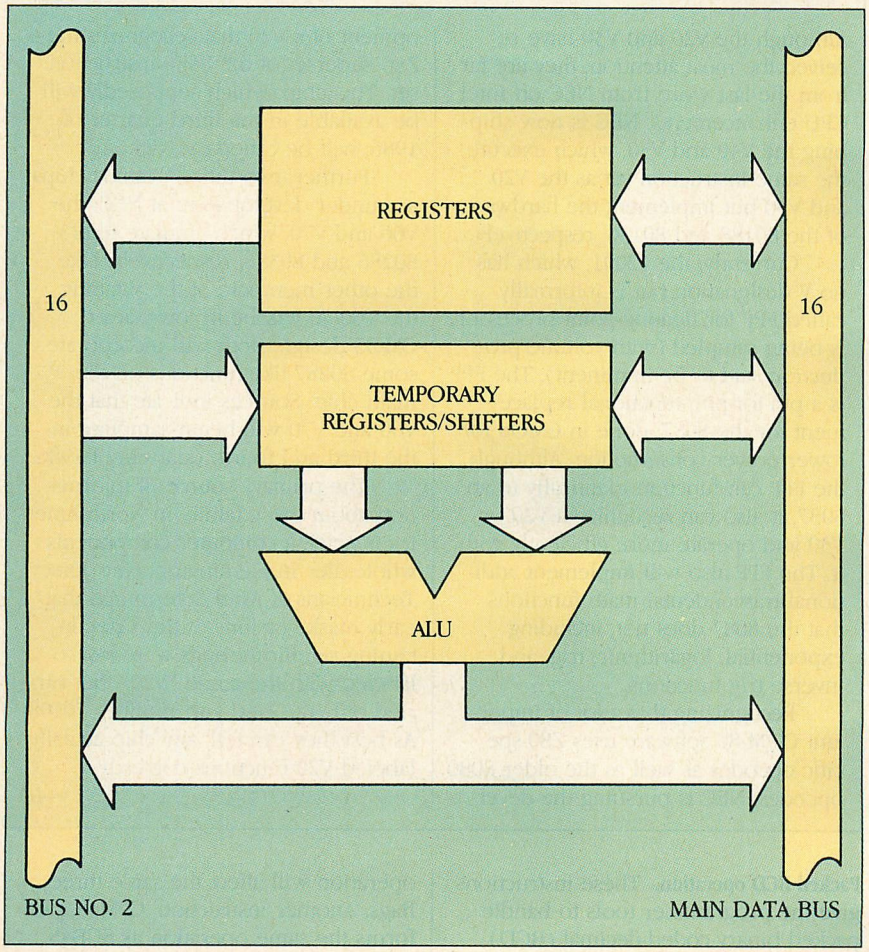
NEC altered the names of most registers to avoid copyright conflicts with Intel. Registers possessed by both chips function identically.

TABLE 2: *The V20/30 Status Word*

V20/30 BIT	NAME	DESCRIPTION	8088/86 EQUIVALENT
0	CY	Status flag–carry	CF
1	—	Reserved–pushed onto stack as 1	Reserved
2	P	Status flag–parity	PF
3	—	Reserved–pushed onto stack as 0	Reserved
4	AC	Status flag–auxiliary carry	AUX
5	—	Reserved–pushed onto stack as 0	Reserved
6	Z	Status flag–zero	ZF
7	S	Status flag–sign	SF
8	BRK	Control flag–break	TF
9	IE	Control flag–interrupt enable	IF
10	DIR	Control flag–direction	DF
11	V	Status flag–overflow	OF
12	—	Reserved–pushed onto stack as 1	Reserved
13	—	Reserved–pushed onto stack as 1	Reserved
14	—	Reserved–pushed onto stack as 1	Reserved
15	MD	Control flag–mode	No equivalent/rsrvd

Most of the changes are in nomenclature only; all flags possessed by both processors work identically. The MD flag specifies native or 8080 emulation mode.

FIGURE 1: *Dual Data Bus Structure of the V20/30*



Note that bus 2, added by NEC, is *not* bidirectional, as is the main data bus.

TABLE 3: *V20/30 Performance Benchmarks*

COMPUTER/CONFIGURATION	SYSINFO	HILB	MULDIV	SIEVE
Compaq Portable (with)				
8088	1.0	7.09	31.86	0.83
V20	1.8	6.65	30.65	0.71
Compaq Deskpro (with)				
8086 4.77 MHz	1.0	6.89	30.79	0.78
V30 4.77 MHz	2.1	6.14	28.27	0.75
8086 7.14 MHz	1.7	3.56	14.93	0.74
V30 7.14 MHz	3.9	3.05	14.94	0.72
IBM PC/AT	5.7	2.53	12.14	0.33

All times are in seconds.

HILB inverts a 10-by-10 real number matrix via the Gauss-Jordan method. MULDIV executes 10,000 real number multiplies followed by 10,000 divides.

eight general registers onto the stack and pop them from the stack. Programmers will recognize that they correspond to Intel's PUSHA and POPA instructions for the 80186/188:

```
PUSH R
POP R
```

Enhanced multiplication. The following sequence performs a 16-bit multiply on the contents of a register or memory location and immediate data. These instructions correspond to Intel's IMUL (integer immediate multiply—signed):

```
MUL reg16,imm16
MUL mem16,imm16
```

Enhanced shift and rotate. This group corresponds to Intel's shift/rotate register/memory by count instructions. The following sequence allows the contents of a register to be shifted by the number of bits specified in imm8, the immediate 8-bit data operand:

```
SHL reg,imm8
SHR reg,imm8
SHRA reg,imm8
```

This sequence rotates the contents of a register by the number of bits specified in the immediate data operand:

```
ROL reg,imm8
ROR reg,imm8
ROLC reg,imm8
RORC reg,imm8
```

Check array boundary. This instruction verifies that index values pointing to the elements of an array data structure are within the defined range:

```
CHKIND reg16,mem32
```

The lower limit of the array should be in memory location mem32, the upper limit in mem32 + 2. If the index value in reg16 is not between these limits when CHKIND is executed, a BRK 5 will occur, which causes a jump to the location in interrupt vector 5. Obviously, this extremely powerful instruction could be a big time-saver for programmers. However, it will pose a problem for the PC and compatibles, which use interrupt 5 to implement PrtSc. This problem was also evident with the 80286 chip and the PC/AT, but has since been corrected. CHKIND corresponds to Intel's BOUND instruction.

Block I/O. These instructions input or output a string to or from memory when preceded by a repeat prefix. They correspond to Intel's INS and OUTS instructions for the 80186/188:

```
OUTM DW,src_block
INM dst_block,DW
```

Stack frame. The first stack frame instruction corresponds to the 80186/188-specific instruction ENTER:

```
PREPARE imm16,imm8
```

This command generates the stack frames required by block-structured languages, such as Pascal and Ada. The stack frame consists of two areas: the first has a pointer that points to another frame that has variables the current frame can access; the other is a local variable area for the current procedure.

The second instruction, DISPOSE, corresponds to the 80186/188-specific instruction LEAVE. It releases one stack frame from those that have been generated by PREPARE. DISPOSE returns the stack and base pointers to the values they had before PREPARE was used to call a procedure. These two instructions are useful to compiler developers.

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UNIQUE INSTRUCTIONS

The V20/30 have a set of instructions not available on the 8088/86. NEC has developed compilers and development tools that support these instructions on a variety of machines, from the IBM PC to the DEC VAX. These tools are expected in mid 1986. At least one PC compiler, Microtec's Professional Pascal, generates code that takes advantage of these additional instructions.

Variable length bit filed operation. The two instructions included in this category, INS (insert bit field) and EXT (extract bit field), are highly effective for computer graphics and high-level language applications. They can be used for data structures such as packed arrays and record type data used in Pascal, or to generate a highly effective BITBLT (bit block transfer) routine for moving portions of a graphics raster from one area of memory to another.

The following sequence transfers low bits from the 16-bit AW register (the number of bits is specified by the second operand) to the memory location specified by the segment base (DS register) plus the byte offset (IY) register. The starting bit position within this byte is specified as an offset by the lower 4 bits of the first operand.

```
INS reg8,reg8
INS reg8,imm4
```

After each data transfer, the IY register and the register specified by the lower 4 bits of the first operand are automatically updated to point to the next index field. Either immediate data or register may specify the number of bits transferred (second operand). Because the maximum transferable bit length is 16, only the lower 4 bits of the specified register (00H to 0FH) will be valid.

This EXT sequence loads into the AW register the bit field data whose length is specified by the second operand of the instruction from the memory location specified by the DS0 segment register (segment base), the IX index register (byte offset), and the lower four bits of the first operand (bit offset):

```
EXT reg8,reg8
EXT reg8,imm4
```

When the transfer is complete, the IX register and the register specified by the lower 4 bits of the first operand are updated automatically to point to the next bit field. Either immediate data or a register may be specified for the second operand. Again, because the maximum transferable bit length is 16 bits, only the lower 4 bits of the specified register (0H to 0FH) will be valid.

THE FUTURE OF THE V FAMILY

Although the V20 and V30 have received the most attention, they are far from the last word from NEC on Intel CPU enhancements. NEC is now shipping the V40 and V50, which execute the same instruction set as the V20 and V30 but implement the hardware of the 80188 and 80186, respectively.

Currently, the 72091, which has no V designation but is informally called FPP for floating-point processor, is being sampled (with volume production said to be imminent). The FPP is a pin-for-pin, functional replacement for the 8087, done in CMOS for lower power consumption. Although the FPP can function identically to an 8087, it also can recognize a V20 or V30 and operate more efficiently with it. The FPP also will implement additional trascendental math functions that the 8087 does not, including exponential, logarithmic, trig, and inverse trig functions.

Recognizing that a lot of important CP/M-80 software uses Z80-specific opcodes as well as the older 8080 opcodes, NEC is pursuing the development of a V20 that recognizes the Z80 superset of the 8080 instruction set. This chip, which supposedly will be available in the third quarter of 1986, will be called the V25.

Further, two more V-family chips are under development at NEC: the V60 and V70, which emulate Intel's 80286 and 80386, respectively. Like the other members of the V family, the V60/70 will be in low-power CMOS design. Both will incorporate some 80287-like functions on the main chip. Sources indicate that the V60 and V70 will begin sampling in the third and fourth quarters of 1986.

The primary source of information about the V family in North America is Ariel, a computer components wholesaler in Flemington, New Jersey. Technicians at Ariel determined that early mask versions of the V20 containing significant bugs were *not* labeled with the name "V20", but carried only the NEC part number 70108. As best they can tell, any chip actually labeled V20 functions correctly.

—JD

Packed BCD operation. These instructions give the programmer tools to handle packed binary-coded-decimal (BCD) operations. The BCD format is used mostly in business applications where numeric precision is a requirement. The instructions described here process packed BCD data as strings (ADD4S, SUB4S, CPM4S) or byte-format operands (ROR4, ROL4). To perform string processing for the rotation instructions, the programmer must use the macro instructions ROR4S and ROL4S, available with NEC's language and assembler support software tools.

First, ADD4S adds the packed BCD string addressed by the IX index register to the packed BCD string addressed by the IY index register and stores the result in the string addressed by the IY register. The length of the string (the number of BCD digits) is specified by the CL register, and the result of the operation will affect the overflow (V), carry (CY), and zero (Z) flags.

Next, SUB4S subtracts the packed BCD string addressed by the IX index register from the packed BCD string addressed by the IY register, and stores the result in the string addressed by the IY register. As for the ADD4S instruction, the length of the string is specified by the CL register, and the result of the operation will affect the same three flags. Another instruction, CPM4S, performs the same operation as SUB4S, except that the result is not stored. Only the three flags are affected.

Finally, the ROL4 instruction treats byte data in the register or memory directly specified by the instruction byte as BCD data and uses the lower 4 bits of the AL register to rotate that data one BCD digit to the left. ROR4 works like the ROL4, except that the end result is a shift of one BCD digit to the left.

Bit manipulation. These instructions manipulate individual bits within registers or memory locations. They are useful in bit-mapped graphics applications.

The first, TEST1, tests a specific bit in a register or memory location, returning the current bit state in the Z flag. If the bit is 1, the Z flag is reset to 0; if the bit is 0, the Z flag is set to 1. The NOT1 instruction inverts a specific bit in a register or memory location. The CLR1 and SET1 commands clear or set (respectively) a specific bit in a register or memory location.

Repeat prefix. These instructions permit high-speed primitive block transfers to be executed repeatedly based on the status of the CY flag. REPC causes the microprocessor to repeat the subsequent primitive block transfer instruc-

tion until the CY flag becomes cleared. Similarly, REPNC causes the next primitive block transfer to be repeated until the CY flag becomes set.

Floating-point operation. These are used for the floating point processor (FPP).

FPO1 fp-op,mem
FPO2 fp-op,mem (new)

The floating-point operation is passed to the floating-point processor when the CPU fetches one of these instructions. From this point the CPU performs only the necessary auxiliary processing (effective address calculation, generation of physical addresses, and start-up of memory read cycle). The floating-point processor always monitors the instructions fetched by the CPU. When it interprets an instruction as one of its own, it performs the appropriate processing.

Standby function. The V20/30 standby mode reduces power consumption by 90 percent during wait states. This mode can be important to battery-operated systems. The HALT instruction sets this mode in both native and emulation modes. In standby mode, the internal clock is supplied only to those circuits involved in exiting standby mode. This mode is released by inputing a RESET signal or an external interrupt (NMI, INT). The bus hold function (in which the V20 removes itself from the bus to let a coprocessor temporarily take control) is effective during standby. The CPU returns to standby mode when the bus hold request is removed.

8080 emulation. In addition to replacing the 8088 and 8086, the V20 and V30 can emulate fully the instruction set of the 8080 8-bit microprocessor. Four instructions are involved in entering and exiting 8080 emulation mode. The BRKEM imm8 command initiates 8080 emulation mode. BRKEM (BReaK for EMulation) operates like the 8088 INT instruction, except that BRKEM resets the mode flag (MD) to 0. The PSW, PS, and PC registers are saved onto the stack; the MD flag is reset; and the interrupt vector specified by the operand imm8 of this command is loaded into PS and PC. The instruction codes of the interrupt processing routine that has been jumped to then are fetched. The CPU then executes these codes as 8080 instructions. (The registers and flags of the 8080 are mapped onto those of the V20/30 as shown in table 4.)

The use of independent stack pointers (SP in native mode, BP in 8080 emulation mode) permits separate stack areas to be defined for each mode. Separate pointers also keep the stack of one of the modes from being destroyed by stack operations of the other mode. The native mode SP, IX, IY, and AH registers are not affected by any operations executed during emulation mode.

TABLE 4: *V20/30 Mappings*

REGISTERS 8080	V20/30
A	AL
B	CH
C	CL
D	DH
E	DL
H	BH
L	BL
SP	BP
PC	PC
FLAGS 8080	**V20/30**
C	CY
Z	Z
S	S
P	P
AC	AC

The V20/30 can emulate Intel's first single-chip 8-bit CPU, the 8080.

In the 8080 emulation mode, the code segment register is defined by the PS register (set by the interrupt vector) and the data segment register is defined by the DS0 register. This last item must be set by the programmer immediately before 8080 emulation mode is entered.

When the RETEM command is executed in 8080 emulation mode (interpreted by the CPU as an 8080 instruction), the CPU restores the PS, PC, and PSW (just as if it were returning from an interrupt service routine) and returns to the native mode. At the same time, the state of the mode flag (MD), which was saved to the stack by the BRKEM instruction, is restored to a value of 1. The CPU is now in native mode and executes all subsequent instructions as normal V20/30 instructions.

The CALLN imm8 instruction calls native mode subroutines while in 8080 emulation mode. The RETI instruction is executed from the native mode subroutine to return to 8080 emulation. In this manner, system calls that normally would be serviced by 8080 subroutines in a CP/M environment can be mapped to native mode service routines without having to develop new 8080 code to take care of system functions.

The processing performed when this instruction is executed in 8080 emulation mode is similar to that performed when a BRK is executed in native mode. The imm8 operand specifies an interrupt vector type. The contents of the PS, PC, and PSW are pushed onto the stack and an MD flag value of 0 is saved. The mode flag is set to 1, and the interrupt vector specified by the operand is loaded into the PS and PC.

RETI id used to return from interrupt routines entered by the BRK instruction or by an external interrupt in the native mode. When this instruction is executed at the end of a subroutine entered by the execution of a CALLN instruction, the operation that restores the PS, PC, and PSW is restored; however, 8080 emulation mode value of the mode flag (MD) is restored, the CPU is set in emulation mode, and 8080 emulation is resumed at that point.

AN INTERESTING ROUTE

Clearly, NEC has taken an interesting path in enhancing the already powerful 8088/86 CPU family. Thus far, few difficulties have been reported; most of these have been in connection with copy-protected software that used exotic schemes to determine whether or not an authorized copy of the program were in use by checking a key disk.

Will the V20/30 find a market in the IBM-dominated arena? Its speed improvement is modest, but it is inexpensive ($18-$25 retail) and does not require an expansion slot. Its low power consumption can be a benefit in machines with heat or borderline power supply problems. (See the sidebar "V20 Compatibility and Performance.")

Will the V20/30's enhanced instruction set find any use? It is unlikely that independent software developers will offer applications that use its expanded instruction set. Some major corporations with significant investments in custom CP/M-80 software have acquired V20s as a means of standardizing on the IBM PC without having to recode the CP/M-80 applications for PC-DOS; they are using CP/M-80 emulator programs.

Finally, a new generation of PC compatibles from Japan might realize performance advantages by incorporating BIOS firmware coded specifically for the V20, while maintaining complete 8088 compatibility. The V20 may provide too little performance improvement to become an important product. (See the sidebar "The Future of the V Family.") But for those applications in which the PC is already strained, the V20 could provide the added muscle to get a difficult job done.

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V20 COMPATIBILITY AND PERFORMANCE

The specifications of the NEC V20 microprocessor are indeed impressive, but just how does the product perform in the IBM PC? Do any ill effects result when it is used to replace the 8088? The answer appears to be no. Every program tested ran on the V20 as it would on the 8088, including some that were copy protected with schemes that are particularly sensitive to timing considerations. Prolok, which sometimes refuses to run for no apparent reason, had no problems. Several versions of SuperLok also ran without problems, as did proprietary protection schemes (such as Microsoft, pre-SuperLok Lotus, and others) and a variety of games. In short, compatibility seems excellent.

A major reason for this compatibility is that the V20 is modeled on the Intel 80188 processor. It implements the features of the 80188, with the exception of on-chip integration of support functions, such as the timer and interrupt controller. All of the 80188 instructions are supported; this, however, is of academic interest only, because no applications software uses them. The IBM/Microsoft assembler can generate these instructions, but any program that incorporated them would be able to run only on the handful of systems equipped with a V20 or 80188. The generation of memory addresses is performed in hardware rather than through microcode. This is of more practical interest because it is transparent to applications.

Nothing seems to be lost by switching to the V20, but just what is gained? To find out, several test programs were run to determine the performance at a variety of levels, from timing individual instructions to high-level applications functions. The results are listed in the table that accompanies this sidebar.

The architecture of the V20 indicates that address generation and branching should be significantly faster than with the 8088. The worst-case addressing mode, base plus index plus displacement, was chosen for the test. For the 8088, this takes 12 clock cycles, whereas the V20 claims to generate any address in only 2 clock cycles. The speed improvement of the V20 turned out to be 17 percent, much lower than expected. The user must remember that other operations also are being performed at the time of address generation (addition and looping, for example), but the sixfold improvement in addressing efficiency would seem to translate to more than 17 percent overall.

Similarly, the branching test showed only a 17 percent improvement, despite the V20's pre-fetch pointer, which is intended to significantly speed up nonsequential execution. As already explained, a 17 percent increase in speed cannot be considered significant. The third low-level test, counting down a register, showed no improvement at all. This is another reason for the high degree of compatibility between the V20 and the 8088, because timing loops that use a countdown in CX are used extensively in the BIOS and other low-level system programs to control I/O devices.

These three tests were timed with microsecond resolution using a program developed by Bob Smith and Tom Puckett ("Life in the Fast Lane," *PC Tech Journal*, April 1984, p. 62).

In addition, tests were run on four types of applications: number crunching, spreadsheets, word processing, and graphics. The results with the Pascal programs replicate fairly closely the results obtained with the Compaq. To test the V20's handling of eight-byte IEEE (8087 format) real numbers in software, the MULDIV program also was translated to C (Turbo Pascal uses nonstandard six-byte reals if no 8087 is used). The results from these tests were especially disappointing, showing only a two percent speed increase. The real number computations were repeated in binary-coded-decimal mode using Turbo-BCD. Here the V20 scored better results. Inverting a matrix in BCD is not a common operation, but the efficiency in BCD computations could help in complex accounting applications, such as interest calculations.

Pascal and C programs were timed by internal routines that read the system timer (55-millisecond resolution); BASIC was timed using the TIME$ statement (1 second); and the spreadsheet, word processor, and power-up processes were timed with a stopwatch. In the latter case, the reported times are the average of sev-

TABLE: *V20 on the PC: Performance Benchmarks*

	8088	V20	SPEED INCREASE	TIMING RESOLUTION
Norton SI Index	1.0	1.8	80%	N/A
Power-on self test[a]	54.000	49.000	10	0.50
Install EMM driver[b]	79.500	76.500	4	0.50
Count down CX[c]	0.248	0.248	0	0.000001
Address generate[d]	0.869	0.744	17	0.000001
Branching[e]	0.993	0.851	17	0.000001
SIEVE.PAS	0.830	0.710	17	0.06
HILB.PAS	7.200	6.800	6	0.06
With 8087	3.400	3.000	13	0.06
With BCD	34.000	27.300	25	0.06
MULDIV.PAS	32.500	30.800	6	0.06
With 8087	6.300	6.100	3	0.06
With BCD	72.900	66.200	10	0.06
MULDIV.C	384.600	375.300	2	0.06
With 8087	23.700	23.200	2	0.06
HAT.BAS (graphics)[f]	718.000	657.000	9	1.00
1-2-3 recalculate	94.500	86.000	10	0.50
With 8087	51.000	48.500	5	0.50
MS WORD repaginate	32.000	30.500	5	0.50
Spell check	77.000	70.500	9	0.50

All figures in seconds except SI index.

[a] *Switch on to first disk I/O; 640KB memory.*

[b] *AST Expanded Memory Manager with 2MB expanded memory.*

[c] *65,536 iterations.*

[d] *ADD WORD PTR [BX+DI+2],1; 65,536 iterations.*

[e] *Forward 10 bytes, back 8, forward 10; 65,536 iterations.*

[f] *Compiled; see "A Diversionary Benchmark," Susan Glinert-Cole, July/August 1983, p. 95.*

Although the V20 is measurably faster than the 8088, the speed increase is not noticeable in interactive computations. Timings with one-half second resolution were taken by stopwatch, others by various programmed time routines (see text).

eral trial times and should be accurate to within one-half second.

The V20's best results were obtained in Norton's System Information (SI) program (a part of the Norton Utilities). Just what this test does is obscure, but the V20 does it very well. For useful applications, the speed increase of the V20 over an 8088 running this test is about 10 percent.

Replacing the microprocessor with a V20 is a good idea for systems that fall just short of the required performance in realtime and high-compute applications. In interactive use, the most time is spent waiting for keyboard input, and the user's perception of the system's speed depends on how fast the next keystroke is accepted. In these situations, the user will barely notice a speed increase of 100 percent, let alone 10 percent. Users looking for a low-cost means of gaining some of the speed of an 8087 or accelerator board will be disappointed.

The 100-percent threshold for noticing changes in physical phenomena is obvious in most units of measurement. In audio, for example, a sound level difference of three decibels represents either a doubling or halving of sound intensity; it is the minimum difference that can be noticed by the untrained listener. In photography, one f-stop represents either twice or half the light intensity passing through a lens and causes a barely noticeable change in the brightness of the image recorded on film. Smaller differences (one db or one-third f-stop, for example, which represent a 26-percent change) are detectable only with measuring instruments. Similarly, the differences in computation speed between the V20 and the 8088 is easily measurable with a timer, but not so easily noticed by the human observer.

—TED MIRECKI

LISTING 1: MULDIV.PAS

```
program mul_div;

var

     hour,min,sec,frac,nr,i : integer;
     a,b,c                  : real;

procedure TIMER;

type
    REGPACK = record
                  AX,BX,CX,DX,BP,SI,DI,DS,ES,FLAGS : integer
              end;

var
   regs: Regpack;

begin
     with REGS do
     begin
          AX := $2C00;
          MsDos(REGS);
          HOUR := hi(CX);
          MIN  := lo(CX);
          SEC  := hi(DX);
          FRAC := lo(DX);
     end;
end;


begin
     writeln('Ten thousand multiplications, ten thousand divisions');
     writeln;
     nr := 5000;
     a  := 2.71828;
     b  := 3.14159;
     c  := 1;

     timer;
     writeln('START: ',min,':',sec,'.',frac);
     for i := 1 to nr do
     begin
        c := c*a;
        c := c*b;
        c := c/a;
        c := c/b;
     end;

timer;
writeln('END  : ',min,':',sec,'.',frac);
writeln('Done.');
writeln('Error = ',c-1);
end.
```

LISTING 2: SIEVE.PAS

```
program SIEVE;

const
  size = 7000;

var
  flags                          : array [0..7000] of byte;
  hour,min,sec,frac,count,i,prime,k : integer;

procedure TIMER;
type
  REGPACK = record
              AX,BX,CX,DX,BP,SI,DI,DS,ES,FLAGS : integer
            end;
var
  regs: Regpack;

begin
   with REGS do
     begin
        AX := $2C00;
        MsDos(REGS);
        HOUR := hi(CX);
        MIN  := lo(CX);
        SEC  := hi(DX);
        FRAC := lo(DX);
     end;
end;

begin
     writeln('Sieve of Erastosthenes'); writeln;
     count := 0;
     for i := 0 to size do flags[i] := 1;
     timer;
     writeln('Start : ',min,':',sec,'.',frac);
     for i := 0 to size do
         begin
              if flags[i] = 1 then
                 begin
                      prime := i+i+3;
                      k := i + prime;
                      while k <= 960 do
                            begin
                                 flags[k] := 0;
                                 k := k + prime;
                            end;
                    count := count + 1;
                 end;
         end;
     timer;
     writeln('Start : ',min,':',sec,'.',frac);
     writeln(count,' primes found.');
end.
```

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We have a devilishly clever solution for the two of you we call PadLock™. It gives you the keys to lock up any program you want—yours or someone else's—without buying a stockpile of expensive fingerprinted disks.

PadLock is software. One of its programs formats any manufacturer's disk, embedding your secret code in sectors the operating system will ignore. Another program installs this code in any program files you name, whether YourProg or WordStar®, or any .COM or .EXE files. From then on there's no picking the lock without the combination: the coded software together with a coded disk.

So it's not despised copy prevention. Protected programs can be copied anywhere, to hard disks, to backup diskettes. It's a lock and key scheme. A protected program will just lock up at load time without a keyed diskette (possibly its own) in one of the drives. The key disk may then be removed to free the drive.

PadLock is economical. You buy software that fingerprints disks for as little as $2.50 each, not $8.00 laser-drilled disks you may never use. Tell you what. PadLock keeps track of how many disks it has formatted. Try it out. Format up to 5 test disks. If PadLock doesn't suit you, return it within 30 days for full refund.

Incidentally, don't look elsewhere. PadLock is available only from PC Brand.

Ask for:	Prices:
M0030 Formats 30 disks	$99
M0100 Formats 100 disks	$250

CURSES *Unix Style Screen Management*

Curses is a Lattice® creation which manages the screen of the IBM PC in the same fashion as the curses utility of Unix. This C library has all the same functions of Unix curses with matching parameter lists. So your Unix program will be content when you move it to the PC, and programs created on the PC will be Unix compatible.

Curses is a library of eighty-four functions and macros which can keep any number of screen images in memory. A screen may be full or partial size, and any can be summoned to the physical screen at your programs's command.

The product supports color, and all four memory models. In keeping with the terminal orientation of Unix curses, the physical screen is re-painted (at high speed) only when your program calls a refresh function. Within a screen, Curses employs a vast function set to get characters, wrap lines, scroll, blank lines, highlight—virtually any tool needed to update the screen.

Ask for:	List:	PC Brand:
L0850	$125	$100
L0860 with Source	$250	$200

BRIEF

FOR ANY LANGUAGE

Is Anything But. A Whopper of an Editor

Dvorak in *Infoworld* said it for us: "the word is getting around...that Brief, The Programmer's Editor is simply the best text editor you can buy." With a name that belies its thoroughness, Brief™ has every feature you've ever contemplated for your editor-in-chief. Here goes:

Text, from keyboard or files, is housed in multiple buffers, and scrolled through one or more windows you open, close, resize. A text buffer may be called to different windows to view two areas at once. A change in one changes both. Text may be marked for printing, writing to files, movement to scrap buffers for cut and paste into other buffers, or deletion, with as many "undo" levels as you want.

To find and fix, Brief has text search abilities rivaling "grep", with wildcards for matching, indifference to intervening characters, acceptance of character ranges, even multiple choice of patterns and their replacements.

If you use Lattice, C86™, or Wizard, and have 320k, you can compile your C program without ever leaving Brief. It finds the lines with errors, and marches you through the text for repairs.

Parts of Brief were written with its own Lisp-like macro language. It has structure, 32-character variable names, conditional execution, loops, and you can actually read it! Nothing like the hieroglyphs we've seen elsewhere.

A macro compiler comes with your copy, and pre-written macros in source to give you the flavor. One even turns Brief into a word processor, with margin setting and wraparound. There's even a bulletin board and public domain disks with macros contributed by a mushrooming cult of macromaniacs. A disk full of contest-winning macros comes free with your purchase! (Needs 192k.)

Ask for: U0590	PC Brand:
List: $195	$CALL

PROSPERO'S PRO PASCAL

BORLAND USERS SPECIAL OFFER!

ISO Validated Pascal for Serious Users

Turbo Pascal™ was irresistible at the price but its limitations loom larger as your Pascal expertise expands. Might it be time to look into a truly professional Pascal compiler?

Prospero Software's Pro Pascal™ was awarded a Class A certificate for its faithful implementation of the International Standard for Pascal (ISO 7185) conquering a suite of 740 tests, the only validated Pascal compiler for the PC and 8086 family of machines. Its UK creator has sold several thousand in a worldwide market where standards are a priority.

Turbo cannot compile programs utilizing standard Pascal features that Borland unaccountably sloughed off (e.g., get, put, page, function name passing). That's probably led to wordy equivalents in your programs at penalty of expanded size and run time. Bluntly, "there *is* a Pascal standard. [Borland] is definitely *not* standard Pascal" (Cortesi, *Dr. Dobb's Journal*, 7/85).

Pro Pascal corrects such deviance to make your work acceptable in any circles. Perhaps more enticing, it breaks free of Borland (and MT+™ and IBM®) 64k boundaries. Large memory model programs of 10,000+ lines and 1,000+ identifiers are now possible.

Pascal as defined is austere as an Alp, but Pro Pascal has sturdy outcroppings to hang onto: dynamic strings, random file record access, long integers, single and double precision floating point, an assembler level interface, and (again unlike Borland) separate compilation of program modules for later linking into large programs, so you can develop libraries of oft-used routines. Or disallow these extensions by the /s option whenever you require strict adherence to standard.

Prepare your source program using any text editor and Pro Pascal's three-pass compilation will convert it to Intel relocatable machine code for direct execution. Fast, tight code results which can use the 8087. The sieve runs faster than MS, MT+ or Borland, and produces a program *one third* the smallest of these.

Pro Pascal is a complete system. You get a librarian; a linker which scans libraries, accepts Assembler modules, and constructs overlays quite on its own (no contamination of source code); a cross-reference generator; a source and symbolic debugger offering multiple breakpoints and changable variables; and a runtime library which may be distributed with your work royalty free.

You certainly got your money's worth from Turbo, but Borland's bargain may now be getting very costly, so here's our deal:

Ask for:	List:	PC Brand:
P0100 <	$390	$ 345
P010X < Borland Trade-In*		$ 299

*Upon receipt of original Borland disks

The TOOLSHED™ Trusted Favorites for a Well-Appointed Workbench

CVUE *Text Editor*

CVUE™ is Lattice's text editor which has undelete, full path name support, and features important to programmers: recognition of non-display characters, pattern searching, indenting and undenting.

Supports text files as big as RAM. Compact and fast. Runs in only 64k with no tedious overlays. The real value: Even the binary version offers full customization of keyboard commands. Plus, opt for source code and make this editor truly your own.

Ask for: L2240, List: $75, PC Brand:$69. For Source Code as well, Ask for: L2245, List: $250, PC Brand:$195.

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PRO FORTRAN < *With Source Debugger*

Prospero also offers a polished Fortran which satisfies completely ANSI X3.9-1966 (known as Fortran 66) and adds an abundance of Fortran 77 extensions (which may be blocked as a compile option). Its strict standards mean mainframe to micro compatibility.

Pro Fortran™ supports both small and large memory models, optionally uses the 8087, is equal to Microsoft in speed, but produces extraordinarily compact code—as little as 1/5 and an average of 1/2 the size of Microsoft's in tests we've seen! It comes with a linker, a librarian, and the same source debugger as Pascal above.

Ask for: F0100, List: $390, PC Brand:$345.

LMK *Unix-like "Make" Builds Systems Easily*

Working on a large program (in any language)? Tell Lattice's LMK™ what source files to compile using which options, which modules to assemble into what libraries, what libraries to search, what to link into the final product.

LMK keeps track of the last time every action was performed, and all the steps in your program system which depend on them. Over and over as you write and test, LMK rebuilds your program faultlessly, however intricate the assembly, and saves time doing only what's needed.

Ask for: L2100, List: $195, PC Brand:$159.

CODE SIFTER *Profiler at Bargain Price*

Several expensive programs will now find the sluggish spots in your program; our Code Sifter saves you plenty. It divides .COM or .EXE files into partitions on its own (or you can specify boundaries), then samples your program at precise intervals, counting how many times it finds the instruction pointer in each partition. Between each run Code Sifter can discard less active ranges and re-partition the hot spots, so that you zoom in literally byte tight! You'll see unmistakably where to optimize.

Ask for: N3100, List: $119, PC Brand:$99.

TEXT TOOLBOX *Tames Text Files*

Unix boasts a number of muscular utilities that are migrating to the PC world. Lattice has assembled a cluster of the most useful text management tools into a single package. All now neutralize WordStar file idiosyncracies.

"Grep" looks for text patterns in any number of files. Want all occurrences of a global variable throughout a program system? Want to search all programs in a directory, down paths to other directories, or all files on a disk? Need to find all the function calls in an entire program system? Grep can do it with a powerful expression syntax that goes far beyond your text editor's search command.

"Splat" substitutes new text for matches found using grep's syntax. "Files" can copy or erase files down paths to the point of eliminating full directory structures.

"Diff" compares text files line for line. Its output is a precise list of instructions telling what to do to make two files the same, a list which can handed to "ed" to handle.

"Ed" is similar to the well-known Unix editor. It offers search and replace with grep syntax, block move, read-write, line numbering, append, insert, delete, etc. You can instruct "ed" to apply a file of commands to any number of target files, even complicated changes and text additions, such as output from "diff".

Ask for: L2220, List: $120, PC Brand:$100.

FIRSTIME *C Programmer for Hire. Real Cheap.*

Not interested in interpreters? Then explore the other fast lane to coding: language-specific editors. FirsTime™ is the strongest C editor we have seen, with many more commands and utilities.

FirsTime asks what program structure you want and sets up its skeleton for you: "main", or "function", or "if-else" or "while" or any component of C, with all semi-colons and curly braces tended to.

It puts placeholders into these structures to prompt you to enter code—the conditionals and counters which complete an "if", for example. FirsTime can even transform one type of structure into another, such as "for" into "while" or "while" into "do". It checks that variables you enter have been declared, and highlights errors. Material can be pulled into ten buffers for movement elsewhere. Your last delete is held in one of them for "undoing".

Movement through the screen highlights the successive logical blocks of your program so that structure is always apparent, and can hide lower level statements to show the outer framing of programs. Makes a big contribution to error-free code.

Ask for: E0460	PC Brand:
List: $295	$229

AND GETTING THEM TO YOU AT REDUCED PRICES, FAST. TRY US!

C-TREE

B-Tree File Manager, Source Code, No Royalties!

C-tree™ has been around since 1979. (It became Digital Research's Access Manager™). That means seasoned, sturdy code which hasn't cracked under the weight of prolonged and widespread use.

C-tree comes in C source code, revealing all you've ever wanted to know about how b-trees are written. Provided you bind it into your binary application, you can re-distribute C-tree without royalties.

C-tree's design splits nodes to allow any number of users to access an index file simultaneously even during updates. So multi-user configurations and adaptation to networks are possible. You must write record-locking routines, as they are compiler and operating system dependent, but the documentation shows how.

The latest version has new features: support of variable record length files; multiple key indexes in a single physical file.

Thanks to source code which does not deviate from the K&R standard, C-tree can travel. Tests in many environments prove that C-tree gives your application a ticket to anywhere.

C-tree permits any number of keys for a data file, supports duplicate keys, alpha-numeric or numeric, etc., etc.—it's a comprehensive product with everything you'd expect. Intelligently designed, too, comprising both high level ISAM routines which minimize coding by handling all details of an activity; as well as decomposed step-by-step functions you can access directly. Either way C-tree maintains optimal index structures which will find a record amongst a million ten-byte keys in no more than five disk seeks.

Ask for: F0660 <
List: $395
PC Brand: $329

ESSENTIAL C UTILITY LIBRARY NEW!

300 Functions, 50¢ Each

Nothing pays you back quicker than function libraries, for our money the treasure of the C language.

Essential's huge package has 49 functions for screen movement, character manipulation, color display, and screen save and restore; 49 graphics functions to draw lines, shapes and color fill; 18 to rework strings in novel ways; 27 to set and obtain the default drive and file date/time stamps, plus make, access and remove directories and files; 22 for time and date validation, formatting, and elapsed time computation; 10 to allocate and free memory and execute other programs from within the current program; 24 to capture and control keyboard input; 18 to drive printers; others for communications, sound, and, and...

They are 95% in C, with those accessing DOS and BIOS (used by many of the C functions) in Assembler. Everything is supplied as libraries and as documented source, so even for C savants, there's much to be learned rummaging about. Demos show a sampling of what these procedures can be combined to do, and the manual clearly presents and describes all functions.

Lattice: U0300 / Mk Wms: <
U0301 / C86: U0302 /
DeSmet: U0303
List: $185
PC Brand: $150

30-DAY GUARANTEE

Even after using program disks, you may return any product in this space not coded "<" within 30 days for full refund of purchase price provided it is in our judgment in resalable condition.

PRE-C

Thorough "Lint"-like Analysis Now on the PC

Unix users have always had "lint" to thoroughly clean programs before they disappear into a compiler.

Pre-C™ looms larger than "lint". It finds problems your compiler won't. Problems that a debugger will have trouble figuring out. Even problems which will cause trouble with other compilers.

Pre-C finds all the syntactical tripwires that will blow out a compiler and much subtler problems: code which will never be accessed, casts with suspect conversions, variables declared as external but never used, functions never called, machine-dependent expressions which inhibit portability, obsolete usage.

But the big service of "lint" is this: Compilers work with one module at a time. They know nothing of other modules which only meet up at link time. Pre-C looks at *all segments of your program at once* and reports to you any inconsistencies of inter-module references.

Pre-C uses the Unix System III compiler standard to guarantee maximum portability anywhere in the C world. There are then plentiful command line options to relax such rigor during early coding when work is incomplete.

Use purchased binary libraries? Profile them for Pre-C and it will thereafter insure that function calls from any C program are letter perfect. A miracle worker in speeding large system development. Needs 128k minimum; 192k recommended.

Ask for: P0590
List: $395
PC Brand: $295

EXPORT QUALITY

We ship anywhere. We will prepare export documents and ship to you or your agent by preferred method. Phone or Telex order for speed. To pay by credit card, provide number, expiry date, name and billing address of card. Or wire funds to PC Brand, c/o Chemical Bank, 126 East 86th St., New York 10028, Account 034-016058. We ship immediately and acknowledge by Telex if number provided.

DAN BRICKLIN'S DEMO PROGRAM

Slide Show Your Latest Great Idea

OUTSTANDING

When the inventor of the electronic spreadsheet called with a new program, we sat straight up in our chair. VisiCalc™ was for businessmen, but Dan's latest is for us programmers.

Ever had trouble putting a program idea into words? Programs are screens! Words don't work. The answer: Show your program as a procession of screens.

Dan's new program makes it easy. It creates slide shows that imitate a program's screens and sequential activity.

Create a screen—a snapshot of your planned product as it runs. Anything goes: words, borders, box rules, inverse and underlining of monochrome, foreground and background color on the CGA and EGA. Copy this "slide" forward with a keystroke, change it a little, to show the next instant of run-time. Copy the slide forward again. Create a whole slide show of your program in action. It will seem like the program itself is running.

Each screen is in 80x25 character mode, not bit-mapped graphics. All 250 characters and attributes are available from scrollable lists which pop to the screen. All commands are layered in Lotus-style pop-up menus, with frequent choices mapped to the function keys as well.

Screen areas can be blocked for cut and paste or filled with color or characters, even made to blink. Slides of oft-appearing segments can be made for overlaying and any slide may have several overlays assigned to it.

Slides can proceed at time intervals or in response to keystrokes, and depending on a user's response, you can tell the program to branch anywhere in the slide sequence to create innumerable paths through your show.

Don't make your ideas struggle through coding to get to the screen. Dan's Demo is invaluable to prototype the program you are about to write, to position all the labels, choose the color decor, smoothe out the keystroke interface *before* it gets etched in code. It's blossomed throughout Lotus™, we hear. "Lotus [was] my major test site", says Bricklin.

Each purchase of Dan's Demo entitles you to redistribute fifty copies of the slide projector program along with your show. Plain manual, no binder, to keep the price low because Dan thinks everyone should have one. You'll wish he'd penned Demo then and left VisiCalc for now. (256k).

Ask for: N0100
List: $75
PC Brand: $69

C-DEBUGGER

Source Level Pesticide

Symbolic debuggers at least let you refer to the names you give to variables, functions, etc. in your source programs—so you don't have to debug C programs by way of hex memory addresses. By contrast, switch on the C-Debugger™ source display, though, from the top or any breakpoint, and enjoy the uncanny experience of watching your source code step by, one line at a time. Or skip ahead n lines and display from there. Or browse through source from the surrounding program area—even from another file.

Multiple breakpoints can be assigned to individual lines in your source files. Areas of memory can be set read-only to let a form of write protection find the most elusive bugs, like pointer encroachment. Trace options allow display of function names and lines numbers as executed. Backtrace writes a history of all functions called, a roadmap of how you got lost.

Other commands display and alter memory and registers, show and replace expression values. Simple variables may be referenced directly by name. (Not local names which the compiler doesn't map). C-debugger supports four memory models and several compilers. (256k)

Ask for: S1200
List: $165
PC Brand: $145

dBC *Lattice Library Maintains dBASE Compatible Files With the Power and Speed of C*

dBC links C to dBASE. It creates and maintains files and their indexes which exactly replicate dBASE™ file design. So dBASE can read and update them. And the reverse. dBC™ can use any files created by dBASE. Now C and dBASE can operate on the same data bases interchangably.

That opens up the widespread culture of dBASE installations to exploitation by C programmers, and there are a lot of dBASE users out there. You can tap that market, avoid the resident dBASE language, and gain all the advantages of C with this single product.

dBC's functions parallel all dBASE's file handling commands, many decomposed to give closer control. The manual discusses each backed by demo source files on disk.

Use dBC for custom work for clients, or on its own. It's a complete ISAM file manager for C whether or not dBASE will be used in tandem, supports all four memory models, and can have sixteen index and data files open. Big discount to buyers of both dBASE II and III versions. Specify Lattice, Microsoft 3.x, or DeSmet compiler.

Versions:	List:	PC Brand:
L00II for dBASE II	$250	$225
LCCII With Source	$500	$450
L0III for dBASE III	$250	$225
LCIII With Source	$500	$450

TERMS AND CONDITIONS OF SALE

Licenses: Each price is for a license to use a product on a single computer and does not constitute its ownership. We will inquire for you about site licenses. Except as noted, products may be used to create programs for distribution without royalty payments or additional licenses, provided said programs do not substantially replicate the products themselves.

Compatibility: PC BRAND's standard products are designed to operate with the IBM® PC, XT or AT under PC-DOS and require no more than 128K of RAM unless indicated. Non-IBM machines using MS-DOS: Determine differences from manufacturer, else we cannot advise.

Returns: Defective parts will be replaced. Products coded "<" are rendered unreturnable if you open sealed envelopes containing diskettes. Otherwise, call for authorization to return a product for refund or credit.

Payment: We honor MasterCard, Visa, American Express (no surcharge), wired funds, checks in advance (in NY State, add sales tax), and will ship COD (U.S. only) for cash, money order, or certified check (no fee). Purchase orders accepted from larger corporations and institutions at our discretion if you agree to net 30 days plus 2% a month late penalty thereafter.

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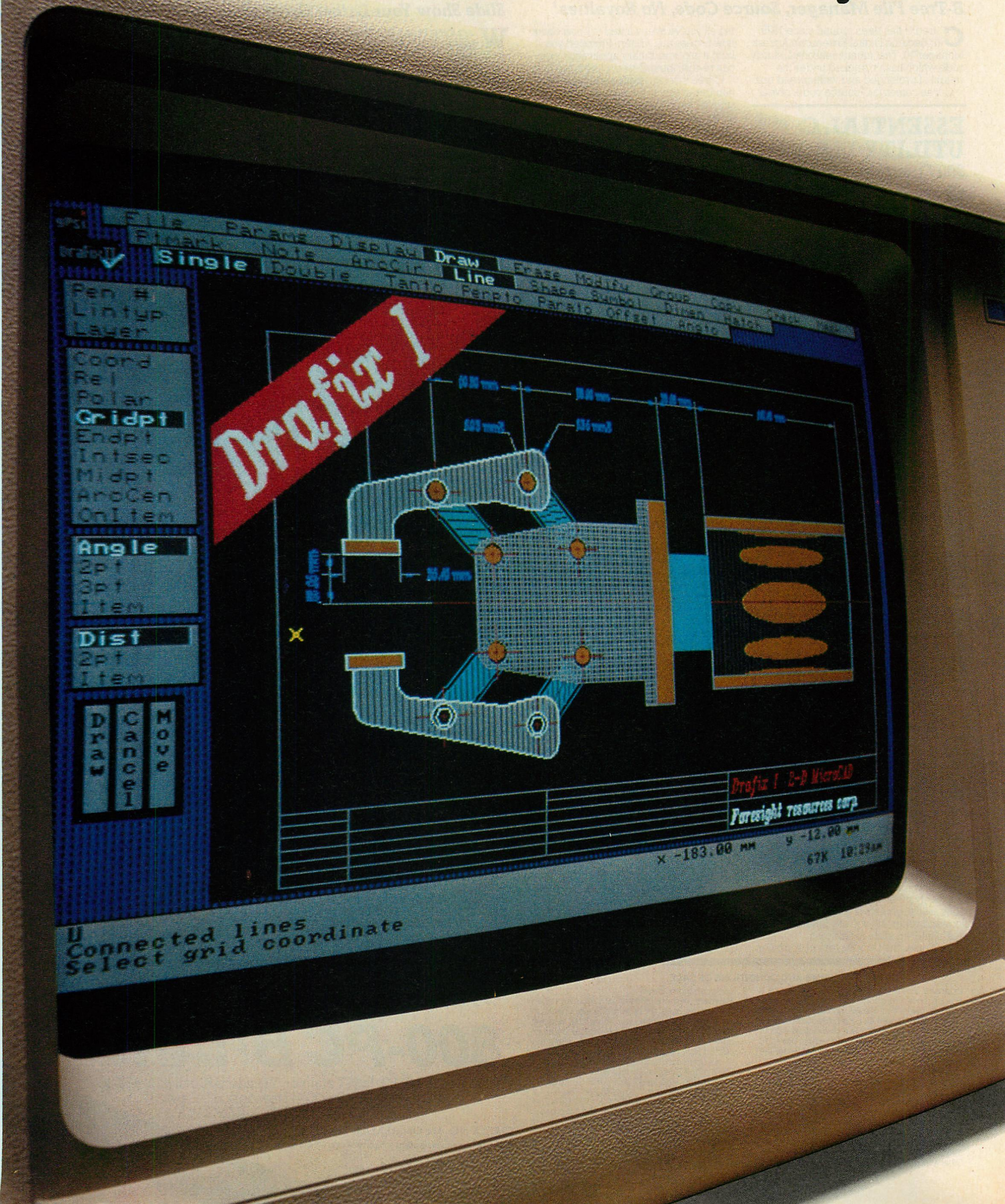
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Item
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y -12.00 mm
67K
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Select grid coordinate

can draw your own conclusions.

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Low-cost, high performance computer-aided design & drafting (CAD) software is finally available for use on your PC.

There's never been a professional CAD package so complete at such a low cost.

Drafix I from Foresight Resources. Only $295.

Powerful, full-featured second generation CAD software.

Drafix I offers all of the capabilities you expect to find in packages costing $2,000 or more.

This is not simply a souped-up paint package. Drafix I is a breakthrough in design that organizes sophisticated CAD functions into smooth, fast operations. All of the drawing, designing and editing functions that designers demand from a serious CAD tool are included in Drafix I.

A breakthrough in screen design and visual user interface.

Drafix I features the best organized screen design ever devised. Very simply, it displays all the information you need, all of the time.

The entire menu hierarchy is displayed constantly. There's no need to memorize commands or search for menus.

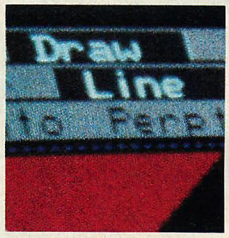
Snap-mode options are continually shown on the left screen border and can be selected "on the fly" by either pointer device or a single keystroke. Roll-down screens provide quick access to the virtually unlimited drawing, display and editing options.

And it's all controlled by a versatile three-button mouse, or digitizer, with on-screen prompts so each button function is clearly defined.

AutoCAD® compatible for easy expansion.

If you or someone in your company already uses AutoCAD, Drafix I offers an inexpensive way to add to your capability.

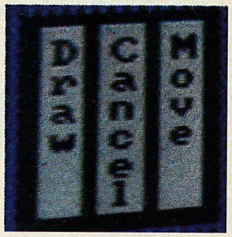
The optional Drafix I/AutoCAD file exchange utility permits transfer of drawings between Drafix I and AutoCAD.



Entire menu hierarchy visible at all times.



Extensive use of roll-down menus.



On-screen prompts define each mouse button function.

It's the perfect, low-cost alternative for increasing your drafting and design capacity.

Low introductory bundle prices.

Drafix I is designed to run on the IBM PC/XT/AT® and compatible personal computers. It supports all major graphics display cards, monitors, printers and plotters.

And to get you up and running we offer two special bundles — all the equipment you need at introductory prices you won't believe.

Get Drafix I with your choice of the Mouse Systems' PC Mouse® or Torrington's Manager Mouse® for just $395.00. Or get Drafix I with SummaSketch 12"x12" digitizer tablet with stylus for just $585.00.

Order today. Take advantage of our 30-day, money back guarantee.

We're so certain you'll like the performance and versatility of Drafix I you're welcome to try it risk free for 30 days. If you're not completely satisfied, return it to us for a full refund.

Find out just how good CAD software can be. For only $295.00.

Use our toll-free number and any major credit card to order your copy of Drafix I today.

SPECIFICATIONS

Code specifications
- Lattice "C" language
- Halo graphics
- Floating point database
- Coprocessor support
- PC-DOS/MS-DOS 2.1 or later

Drafix I Features

Items
- Lines
- Pt markers
- Arcs & circles
- Note text
- Polygons & ellipses
- Symbols/individual & nested

Item attributes
- 16 pen colors
- 255 Layers
- 8 Linetypes
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- 32 Pt marker types

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- IBM PC XT AT and compatibles
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- Zenith
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  - — 512K RAM
  - — RS-232 Comm port
  - — Mouse or digitizer
  - — Coprocessor recommended

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SummaSketch is a trademark of Summagraphics Inc.
Manager Mouse is a trademark of Torrington Company

CIRCLE NO. 108 ON READER SERVICE CARD

Controlling from Afar

Some communications packages offer users the ability to operate their PCs from miles away.

AUGIE HANSEN

Remote control for personal computer users means the ability to run a computer at some distant location from another computer or terminal. Commands can be executed on the remote computer as if an operator were present. Better yet, two computer users at separate locations can link their machines to work on a task together, each seeing the result of both local and remote operations. A useful application of this is providing remote diagnostic capabilities over the telephone. Service representatives can look over the user's shoulder from thousands of miles away and troubleshoot a problem as readily as if they were in the same room with the ailing computer or program.

Several communications packages are devoted entirely or in part to remote control of PCs via available data communications channels. They include Carbon Copy from Meridian Technology, LYNC by Norton-Lambert, and Microstuf's REMOTE. These programs do not have identical purposes, so a head-to-head comparison of them would not be appropriate. Each one, however, has aspects that are related to accessing, controlling, and monitoring one PC from another PC or terminal. Table 1 summarizes the essential features of remote control and shows which of those features are supported by the tested packages. These features are detailed below. (Additional program features that fall outside this realm are covered in the accompanying sidebars, "The Microstuf REMOTE Mail System" and "LYNC Telecommunications.")

System access control. The primary asset that a remote control program must have is the ability to prevent unauthorized access to the computer. The list of possible users must be bounded in some way to prevent the loss of private information, destruction of the storage system, or other malicious acts. The usual way of limiting access via the electronic route is password protection.

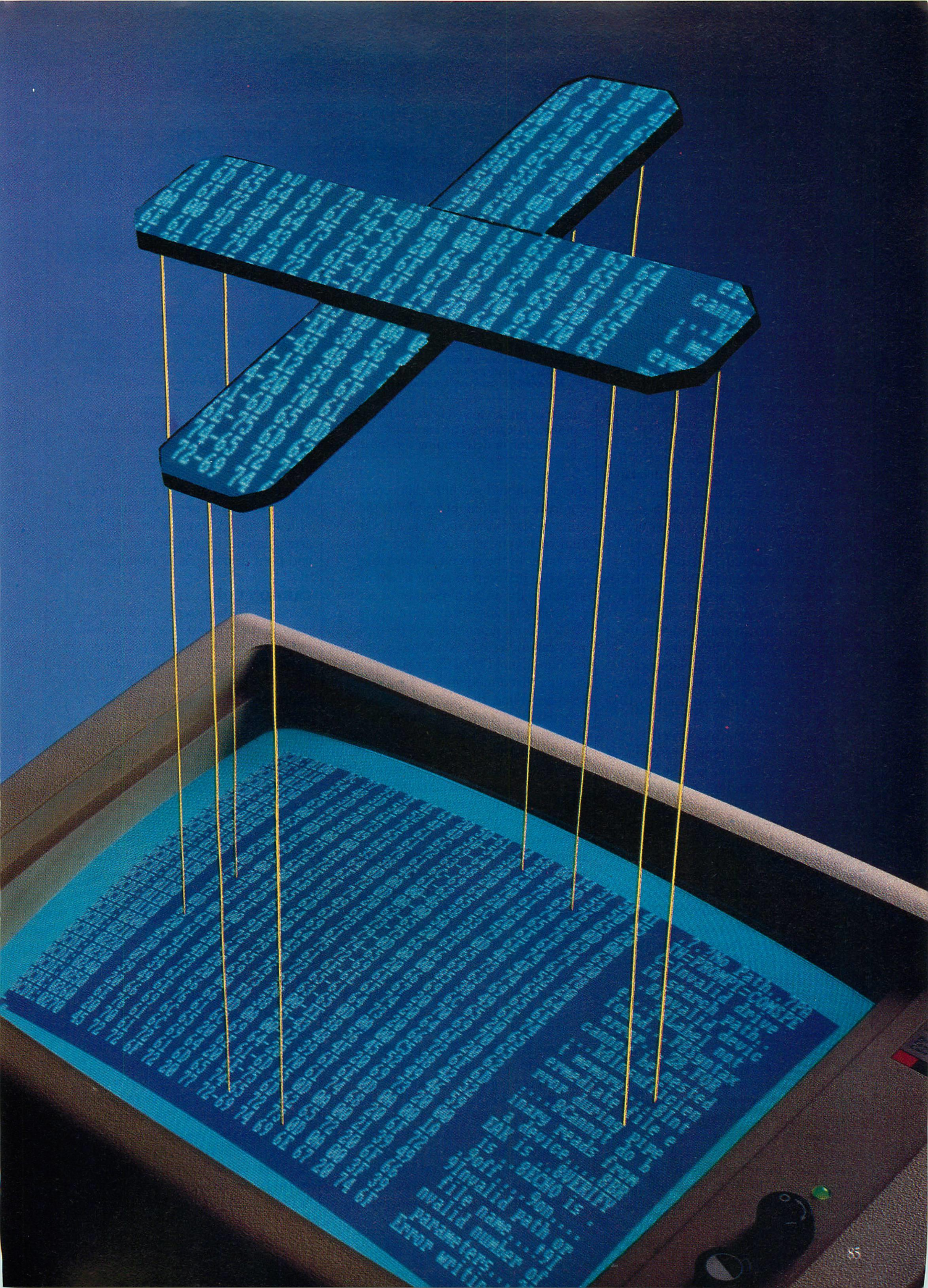
Access from any terminal. For some purposes, access from any terminal or PC running terminal emulation software is a worthwhile feature. General terminal access permits traveling users to check their electronic mail and news, work on manuscripts and programs, and virtually operate as if they were in their normal operating environments.

Two-way conferencing. Two-way conferencing allows users at both ends of the connection to share access and control of a machine. This feature has several uses, including the ability to perform remote debugging or to copy software onto a machine at a remote location for demonstration purposes.

File transfer. Remote demonstration of software also requires a file-transfer feature for transmitting files between machines. To be useful, the facility must be able to transfer both data files (usually ASCII text) and program files (binary). Data encryption is a necessary enhancement to file transfer to keep information from being intercepted by unauthorized persons. This is especially true of data files that must be left on an intermediate system before being delivered to a final destination.



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Chat mode. A feature that permits two users to type messages to each other across the link is usually called chat mode. It is often found on bulletin board systems in which the system operator needs to converse with the logged-in user. In the remote/local system context, the purpose is the same, but both users should be able to initiate and cancel the use of the mode.

DOS command access. A user often needs to run DOS commands and batch files while connected to a remote machine, so some means of escaping to the DOS level, or better yet, operating at the DOS level transparently, is an important part of remote operation. Of equal importance is the ability to run commercial applications programs.

Capturing screen image to disk. Incompatibility between linked systems may be a problem if, for example, one computer is configured with a monochrome and the other with a color/graphics display. Another problem is caused by the screen accesses of most spreadsheets, word processors, and many other applications, which, for performance reasons, are done directly, bypassing the slow operating system (DOS and BIOS) screen routines. A means of conveying images on the remote screen to the local screen is more than a trivial task. Designers take widely differing approaches in handling this situation. (Programs that use the operating system video interface routines are said by IBM to be *well-behaved.*)

A means of capturing screen images to disk, although not essential, is desirable. The objective is to store the data from a displayed image, either graphics or text, so that it can be replayed later or printed out onto paper.

USER'S VIEW

Two classes of operators need to be defined when considering remote control of computers. An *administrator* is responsible for setting up a system and assuring its successful operation. Responsibilities include assigning passwords and distributing software. A *user* has no privileged access and is strictly a beneficiary of the services provided by the remote control programs.

From a user's perspective, two primary types of remote control connections are evident: *unattended* and *attended.* In the case of an unattended remote system, the user is at a terminal or computer referred to as the *local* system. The objective is to log in to the remote system and work as if physical access to the remote system were possible. If remote access is handled well, the user should see little difference compared to sitting physically at the console (keyboard and screen) of the remote system, although some slowing of output to the screen is inevitable.

TABLE 1: *Remote Control Features*

FEATURE	CARBON COPY	LYNC	REMOTE
System access control	Yes	Yes	Yes
Access from any terminal	No	Yes[a]	Yes
Two-way conferencing	Yes	Yes	Yes
File transfer (text and binary)	Yes	Yes	Yes
Chat mode	Yes	No	No
DOS command access	Yes	Yes	Yes
Run DOS applications			
Well-behaved programs	Yes	Yes	Yes
Direct-access programs	Yes	No	Yes[b]
Capture screen image to disk	Yes	No	No

[a] *All terminals are treated as simple printing terminals regardless of their capabilities. No provision is made for using the features of video terminals.*
[b] *The REMOTE implementation of direct screen access is not useful for all hardware configurations.*

Each of the reviewed systems function in a remote control type of situation, but to different degrees. The hardware that is to be used for each end of the link should be a factor in determining the most suitable package.

The first step in using a remote system is for an administrator to set up an automatic answer mode of operation so that those granted access permission may call the remote via some communications channel (dial-up or direct). Assuming that a modem is connected to a telephone line, the most general arrangement, the program should be able to respond automatically to incoming calls and adjust the line speed to match that of the caller. This may require that the caller press a few carriage returns to synchronize the two systems.

Once connected, a log-in/password ritual ensues. Some programs require both a log-in name and a password, others accept just a password, and still others require neither (living dangerously). If the calling party gets past the log-in procedure, the remote host typically presents a command prompt or a menu of some kind. The user should be given enough instruction in advance to know what to expect and how to interact with the remote system.

When both the local and remote systems are attended, the procedure for logging in is usually the same as when the remote computer is unattended. However, once the connection is established, the calling (local) party expects to share the resources of the remote system with its user to do program demonstrations, repair operations, etc.

Another possibility exists. With the proper software, a user could switch between voice and data connections. This obviates the need to hang up and redial a connection and lets users make arrangements for the working session and hold discussions in realtime.

CARBON COPY

Meridian Technology's product offers remote control and monitoring features exclusively. Carbon Copy sacrifices generality for smooth and very tight interactions between two PCs. The product's name is indicative of its function: the linked PCs seem to be literal copies of one another, at least in terms of keyboard and screen interactions.

This program requires that both computers be IBM PCs or compatibles and that each be running a separate copy of Carbon Copy. Meridian Technology suggests that both computers be equipped with the same display systems for greatest compatibility. While no problem was encountered when running text-only programs using a color display system on one machine and a monochrome display system on the other, graphics would be troublesome to such a configuration.

All program disks are serialized and copies with the same serial number cannot talk to each other. The program files can be installed on floppy- and hard-disk systems with equal ease. Care should be taken, however, when using a PC/AT with both standard and high-capacity disk drives. The Carbon Copy disk insists on doing its work in drive A:, even when run in drive B:. If drive A: is high capacity, any standard disk in it can be modified in a way that makes it unreadable. This was learned the

hard way during this review when an attempt was made to initialize the Carbon Copy disk in drive B:. The operating system disk in drive A: was rendered unusable. A program named CCSTART creates the needed working files for the local and remote systems.

Installation and initialization is handled by CCINSTAL. The installation procedure walks the user through the steps needed to set up the communications port, select hardware options, and set up passwords. Up to 20 unique passwords may be created and stored by an administrator. To log in to the remote system, a user needs to know only one of the passwords. Each password may be composed of up to 30 numerals and letters (upper- and lowercase letters are treated the same).

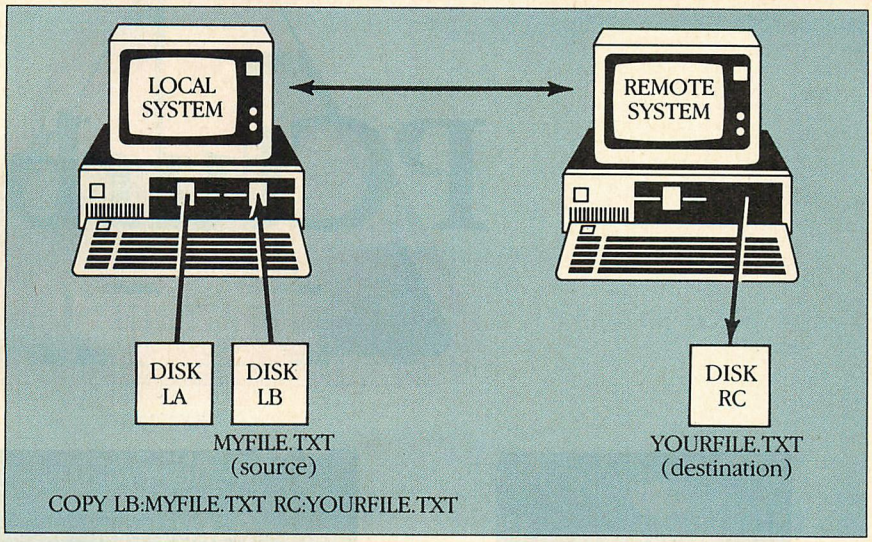
The user at the local system runs the program CCHELP. A call table may be created that permits automatic dialing of systems by name. Needed conversions of names to telephone numbers are done internally. Direct calling using typed numbers is also permitted. The remote user runs the program CC and typically puts the system in automatic answer mode. The machine is left in this state for later use in unattended remote mode. A configuration file may be used to automate this process.

When the local PC connects with the remote PC, and when both systems are attended, the users will most likely enter the chat mode first. In this mode, they can type messages to each other to plan their session. To get down to serious business, either user presses F9 or F10. This action removes the *control* screen to reveal the normal PC working screen of the joint session, which is the default mode of operation.

Carbon Copy has all of the requisite features for remote control. Using an overlay module called CCDOS, it does file transfers in a way that mimics normal DOS copy operations (it uses remote and local drive designations; the local drive A: is designated LA: and the remote drive A: is designated RA:). The contents, all attributes, and the lengths of transferred files are retained. Figure 1 shows the apparent structure of a file-copy operation across systems.

Other DOS-style commands are used to view, rename, and delete files, and to change to and list a directory. CCDOS unlinks the keyboards and screens of the two PCs, but maintains the communications channel. CCDOS restores the symbiotic relationship of the PCs when told to do so by either the local user typing EXIT or the remote user pressing the Esc key.

FIGURE 1: *Copying Files across Systems*



Carbon Copy allows DOS-type commands in CCDOS overlay by using disk drive designations with an *L* prefix for the local system and an *R* for the remote system.

As noted earlier, many applications have direct screen access to obtain speedy performance. Screen updates sometimes take a while to complete. The remote user is generally not aware of any lagging behind, but the local user cannot help but notice this effect. When Carbon Copy is running an editor, for example, the screen on the remote PC is updated at nearly the same speed as it would be in stand-alone operation. The local PC, however, must be updated via the telephone connection and may take a considerably longer time to update (up to 15 seconds for text and 40 seconds for graphics at 1200 bits per second). Such delays may be a bit inconvenient, but they usually will not affect a program's operation. Text screens are updated automatically, but graphics images are sent only upon request to avoid delays.

Carbon Copy can save screen images to disk (F3) and retrieve them (F4). Even when the control screen is visible on top of the normal screen display, the save feature copies only the underlying applications screen to the disk file and correctly handles screen modes (graphics, text). Each image is saved in a named file for easy retrieval at a later time.

In addition, Carbon Copy can switch from data to voice transmission and back. At any time, the local user may request a switch to voice operation. The remote user is informed of the request and can accept or reject it. Convenient screen displays guide users through the process. Voice and data modes are mutually exclusive.

LYNC

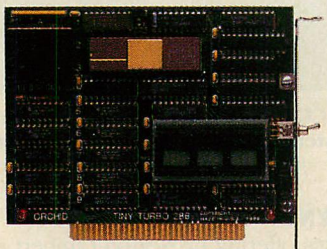
This offering by Norton-Lambert is a general-purpose communications package that includes a PC remote control mode. The program was originally designed for the CP/M operating system and then migrated to the PC. In an effort to span both CP/M-80 and DOS-based systems, LYNC processes all screen images using operating system calls exclusively. It does not run remotely any applications that write directly to the PC display system. Therefore, many of the popular applications programs for the PC cannot be run.

Installation and set-up are straightforward operations that are described adequately in the documentation. The remote operating mode is not compatible with the use of the ANSI.SYS device driver provided with DOS. Because some programs for the PC cannot run without it, this eliminates a few more applications from the list of those that are able to run under LYNC.

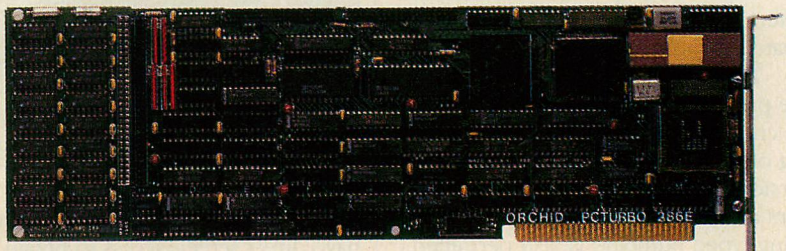
Remote operation of LYNC can be started in several ways. Most frequently, a communications path is established, then one of the users sends a command to start remote operation. A computer may also be set to start REMOTE mode operation automatically when turned on by using a batch file. Only one of the two systems needs to have LYNC running in REMOTE mode. The other can be an ordinary terminal or a computer running emulation software. Password protection may be used, but the default is to run without protection. A password can consist of 19 numerals and letters (case-sensitive).

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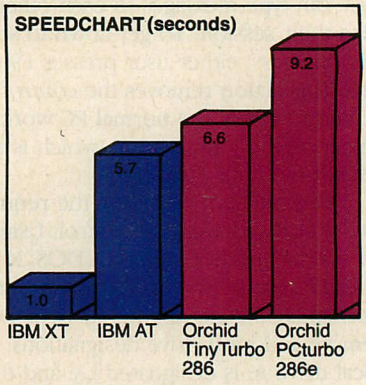
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Files may be transferred between machines using one of several error-free protocols including XMODEM and LYNC's own protocol. LYNC has the added bonus of automatic encryption of any files. It does not support graphics, chat mode, or an image capture feature. It runs programs such as DEBUG, DOS commands such as TYPE, and applications that use the operating system interface to the PC screen.

Because LYNC does not do any video terminal emulations, the REMOTE mode does not provide any support for real video terminals or emulation programs. The TERM mode of LYNC (see sidebar) is a standard TTY emulation, which is satisfactory for accessing information services, bulletin boards, and many time-sharing systems.

Norton-Lambert is releasing two dedicated remote-access packages, which were not available in time for this review. Close-Up Support and Close-Up Customer are expected to sell for introductory prices of $245 and $175, respectively.

REMOTE

Microstuf's entry among remote control products lets a PC be accessed and controlled remotely by another computer or by any terminal. By concentrating on a PC running DOS as the remote and providing two operating modes, this program is able to run most PC programs remotely. (REMOTE also includes a good electronic mail feature, as discussed in the accompanying sidebar.)

REMOTE's two operating modes are called *normal* and *screen*. The program may be switched from one mode to the other by the local (calling) user. The keyboard sequence, Esc=, is used to toggle the operating mode selection. In its normal mode, REMOTE updates both screens in unison using standard operating system calls, so screen updates are slowed down equally on both ends of the connection. Well-behaved programs can be run remotely in this mode.

In screen mode, REMOTE bypasses the operating system calls and updates the screen directly and only in areas that have changed since the last update. This mode does not correctly access the color/graphics board on a PC/XT (the remote machine) during video retrace periods. The result is a very annoying flicker and a blizzard of snow on the screen in pulses at about three per second. Also, the update algorithm causes the local screen to be redrawn after every scrolling operation that adds a new line at the bottom of the screen (a frequent occurrence), dramatically slowing down the process of displaying a file or scrolling a page in an editor.

The PC screen poses a problem for REMOTE when used with a terminal or emulator program. The PC screen has 25 rows, whereas most terminals and computers of earlier vintage usually have 24 screen rows. REMOTE gives the user several solutions to this problem, which, although inelegant, are functional. The user can elect to discard the top or bottom line of the screen, or alternate the 24th line of the terminal or PC between the PC's 24th and 25th lines.

The PC keyboard is another source of frustration for the designers and users of remote control programs. It has keys not often seen on other terminals. Again, REMOTE provides ways of handling the problem. Special two-key sequences are used to simulate the PC's Alt key, cursor control keys, and to switch to and from screen mode.

In screen mode, REMOTE bypasses the operating system calls and updates the screen directly, and only in areas that have changed since the last update.

The program is started by first typing REMOTE to load a resident piece of software and then SIGNON. An options menu lets the administrator select one of six tasks: read system log; send/read mail; list/add/change passwords; change program settings; set date and time; and wait for incoming calls. REMOTE permits the setting of an adjustable time-out interval for logged-in but inactive users, a number of rings before answering, and other system parameters.

REMOTE is password protected to minimize unauthorized access; the system administrator can set a limit on the number of unsuccessful attempts at logging in. The administrator assigns passwords that are kept in a database with the users' names. Each user must be assigned a unique password.

The administrator also specifies the type of terminal a user will be connecting to the remote system. The specification is needed so that REMOTE can use data files from its directory of terminal capabilities to provide the appropriate interaction with the device. This is odd, because a user may not always call in from the same system. REMOTE's method requires multiple entries for each user so terminal types can be selected by logging in with different passwords. Allowing terminal type selection at log-in would be more elegant.

Files may be transferred between the computer running REMOTE and another computer running Crosstalk XVI. The usual XMit and RQuest commands of Crosstalk are invoked to begin the transfers from local-to-remote and remote-to-local systems, respectively. REMOTE does not support any other file-transfer protocols.

Color graphics is not supported by REMOTE; nor does the program have a chat feature. Screen images cannot be captured to a file. However, Crosstalk's data capture feature can be used to save received data to disk or memory to preserve textual information.

HANDLING TECHNIQUES

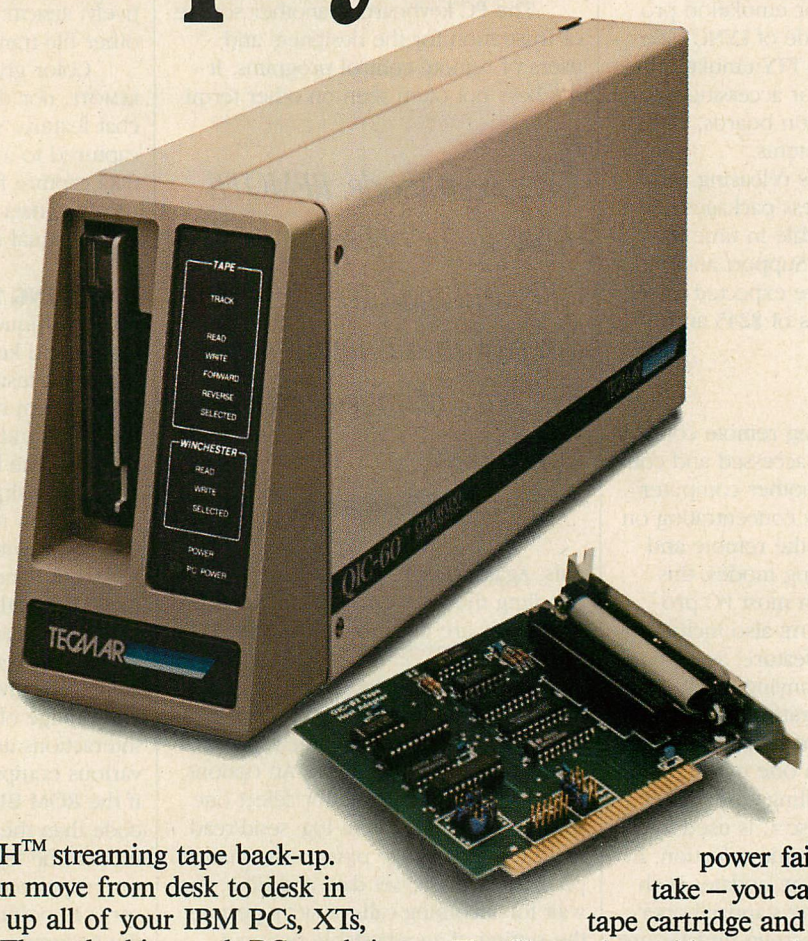
The techniques used to handle the screen and keyboard vary among the programs tested. The base case is to use DOS system calls and interrupts. This is the safest and, unfortunately, slowest method. The keyboard input is usually retrieved using DOS interrupt 21H with the function number set to 08H (console input without echo). The keyboard interrupt handler also can be intercepted directly and characters taken out of the keyboard buffer, if necessary.

Screen processing using DOS and BIOS calls gives a program access to a wide range of machines because such interactions are supported uniformly by various equipment manufacturers. Even if the ROM BIOS has entirely different code than the IBM ROM BIOS (as they must to be legal), and as long as the interrupt vectors used to access needed services point to the correct routines, the programs using the interrupts should work identically.

The commonly used screen routines are in the BIOS group invoked using interrupt 10H. The available services include setting the video mode, positioning the cursor, writing characters and video attributes to the screen, displaying text strings, and scrolling regions of the screen up or down. In addition, certain services retrieve the current video state or mode of operation, read the cursor position, and return the character and attribute at the cursor position. Several DOS functions may be used to display individual characters or entire strings on the screen.

The problem encountered in software that must interact with these rou-

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tines is that the overhead associated with each interrupt is too high. This makes screen updates, in particular, too slow for commercial quality programs. Hence, methods that circumvent the problem have been developed. The methods most often used are, to be sure, less portable than the DOS/BIOS methods just described, but their main virtue is speed.

Because LYNC sticks to the operating system calls, it is the most adaptable to foreign hardware. REMOTE uses a kind of half-way approach so that it can work with simple terminals (and emulators) as the local system. Thus, direct screen access methods may be used on the remote system because it is assumed to be an IBM PC or equivalent machine, but traditional means of sending data to the screen of the local system are used. Standard ANSI control sequences are used for cursor positioning, screen clearing, and other operations on video terminals and emulators. Carbon Copy takes the boldest but least portable approach. It demands an IBM PC or equivalent at both ends and uses direct screen access to gain speed.

Direct screen access, as used by REMOTE, is achieved by knowing the location of the display memory in the PC's address space. For IBM and truly compatible machines, the display memory for a given display type is always at the same place. Some "almost compatible" makers, such as Texas Instruments, use different address spaces for display memory, making the machines incompatible with a lot of IBM-based software.

Assuming that both the local and remote systems are using monochrome displays, direct screen access in REMOTE works as follows. The goal is to keep the local screen in a state that reflects exactly what is displayed on the remote screen. When a character or a block of characters is written to the remote screen, it must also be sent via the communications line to the local system where it is displayed.

The control program on the remote system can do its job in one of two ways. It can intercept the display-writing operations of the applications program that is trying to update the screen and then do the screen updates and the echoing to the local system. Or, it can note that the remote screen has been updated and, when convenient, read the screen data out of display memory and send the changed parts of it to the local system for displaying. Usually a screen buffer, kept in the control program's data space, shadows the actual display memory on the display adapter card. When the contents of the two memory areas differ, as they do after an application writes data to the remote screen, the differing portions of the screen buffer are updated to match the display memory. The remote control program communicates the changes to the local system where similar screen updates take place.

An intriguing problem occurs in REMOTE when an application writes a line of text at the bottom of the remote screen. The top display line is lost and all other lines must be scrolled up to accommodate the new line. If the display memory and the shadow buffer are compared, retransmitting the entire screen will seem necessary to make the local screen match the remote screen.

A more sophisticated approach is used by Carbon Copy. When a scrolling operation takes place, Carbon Copy tells the local PC to scroll too, and then it transmits only the contents of the new data to be added at the bottom or top, cutting the update time to about four percent of that required to update the entire screen. This is possible because Carbon Copy requires the same equipment at both ends of the connection. It works for systems that use different display systems on the local and remote systems (color on one and monochrome on the other) because the control program on each end knows how to interact with its associated display system. This approach cannot be used as easily if the local system is allowed

THE MICROSTUF REMOTE MAIL SYSTEM

The electronic mail feature of Microstuf's REMOTE has proved to be one of the product's most valuable assets.

MAIL is a fairly straightforward implementation of an electronic mail system. Its features should be familiar to anyone who has logged in to one of the many bulletin board systems available to PC users. Most bulletin boards have public mail/message modules, and some permit users to send private messages to other users and the system operator.

The MAIL options are, from the user's perspective, **check** mail to get a brief summary of received messages, **read** mail (with disposition options of **delete**, **save**, and **reply**), and **send** mail (includes a line-oriented editor for preparing and editing messages). Using the **reply** option automatically fills in the "to" and "subject" lines of the reply message header, saving the user some time. A user can read only messages addressed to him or her. The system administrator, however, can read any message, regardless of the addressee.

A welcome feature of this mail system is the use of data encryption to keep messages private. Encryption works in conjunction with controlled access to messages in order to enhance the overall security of the MAIL system. Password-controlled system access further diminishes the possibility of unauthorized viewing of personal mail messages. Originators of mail messages also may ask for a return receipt to verify that a message was received by the addressee.

The built-in editor is simple, but it is adequate for preparing and modifying message text. In addition to insert/delete/modify text options, it permits the text of disk files to be brought in from disk and included as part of the message being edited.

Some MAIL system maintenance is required. Two files, one containing the text of all messages (MAIL.TXT) and the other an index of messages (MAIL.DIR), comprise the MAIL system data storage. Messages that have been saved are marked *old*, but retained for later disposition. Deleted messages are so marked but are not erased automatically. The administrator is responsible for "packing" the mail data files to remove unneeded data.

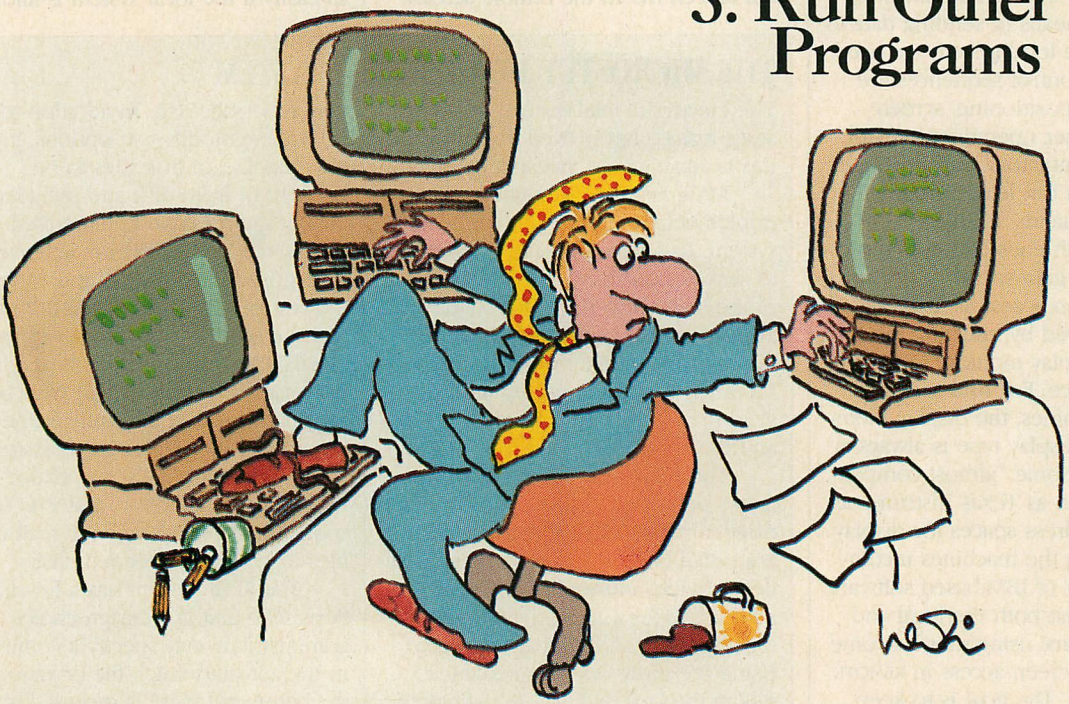
The MAIL system has a few limitations. The first is a design choice. The administrator may specify a command in the autostart batch file of REMOTE. If the command MAIL is included, the user starts up in the MAIL system at the conclusion of a successful log-in attempt. If the MAIL command is not present, then normal REMOTE start-up occurs, and the user is oblivious to any messages that may have been received. This all-or-nothing behavior is not as useful as that of mail under UNIX. The latter notifies the user of the presence of new mail, but does not force the user to read it.

Another limitation is a shortcoming of DOS, not of MAIL. Because DOS is not multiuser, only one user may access the REMOTE system at a given time—and only while the system is not being used for some other task. An electronic mail facility cannot approach its full potential if it is not available all the time.

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to be a generic video terminal, which may not know how to scroll or do other operations that the PC can; this places limitations on the way REMOTE does screen updates.

The transmission of graphic images poses different problems. Whereas a text screen has 4,000 bytes of data (2,000 characters and 2,000 video attributes), a graphics screen has 128,000 picture elements represented by 16,000 bytes of stored data. Differential processing of the images in display memory and program buffers is difficult, and transmitting the data over a typical communications channel is time-consuming. Only Carbon Copy permits the transmission of graphics—and then only on a screen-page demand basis.

Carbon Copy, LYNC, and REMOTE all can tie computers together using standard telephone circuits with suitable line conditioning via modems. They also can work over direct connections if a null modem (signal leads cross-connected) is used to cable the systems together. RS-232 serial connects without line conditioning are good up to about 5,000 feet in most environments. Heavy electrical noise or aerial cabling reduces that distance considerably.

Transmission rates of less than 1200 bits per second make using these programs unpleasant. The preferred rate is 2400 bps; doubling the speed has a profound impact on the perceived speed of the remote link.

In choosing a remote communications package, the operating environment in which the program will be used is a critical factor, as is the intended purpose. Factors such as the types of machines being used and the jobs that will be done should be considered. Carbon Copy is effective for demonstrating programs and doing remote test and repair tasks. If general-purpose access from a range of terminal types is needed, REMOTE is a good choice. LYNC should satisfy a user who is looking only for a general-purpose communications package.

Carbon Copy: $195
Meridian Technology
1101 Dove Street, Suite 120
Newport Beach, CA 92660
714/476-2224
CIRCLE 303 ON READER SERVICE CARD

LYNC: $195
Norton-Lambert
P.O. Box 4085
Santa Barbara, CA 93140-4085
805/687-8896
CIRCLE 304 ON READER SERVICE CARD

REMOTE: $195
Microstuf, Inc.
1000 Holcomb Woods Parkway
Roswell, GA 30076
404/998-3998
CIRCLE 305 ON READER SERVICE CARD

Augie Hansen, formerly on the technical staff at AT&T Information Systems, now owns Omniware, a software development and training company. As a contributing editor for PC Tech Journal, *he has written several articles on communications packages.*

LYNC TELECOMMUNICATIONS

The Norton-Lambert LYNC program program sports a reasonable set of features expected of general purpose communications programs. It offers the XMODEM file transfer protocol in addition to its own proprietary protocol that optionally incorporates data encryption, an electronic mail feature, automation via command scripts, and a generic terminal emulation feature.

LYNC's REMOTE mode is but one of three operating modes. The other two are TERM, which makes the host PC look like a terminal and is used to communicate with other systems that are not running LYNC software; and LYNC mode, which as the name implies, expects the other system in the communications session to be running LYNC software.

In its TERM mode, the LYNC program looks like a simple teletype-style terminal, which is fine for accessing information services, bulletin boards, and electronic mail services.

LYNC in the LYNC mode comes up in a conversational state in which each user sees what the other user types. To run commands, a user presses the Esc key to get a command line. LYNC prompts with @: and awaits the command, which is usually a simple English word in either upper- or lowercase. Many DOS-like commands (DIR, TYPE, etc.) are available in addition to a full set of LYNC program commands. Multiple commands may be typed on a single line if they are separated by semicolons.

HELP displays a list of allowed commands. Typing HELP <command name> elicits a condensed but useful description of the specified command. Most of the names are full words (BELL, DIAL, MODEM, HANGUP, LOG, SAVE) that have good mnemonic value. A few are somewhat obtuse (RD for RE-DIAL, COMS to list commands currently in effect). Users who hate commands and embrace menus will not find happiness here. LYNC steadfastly uses the operating system services to write to the PC screen, so the help frames (and all other screen output) is dead slow.

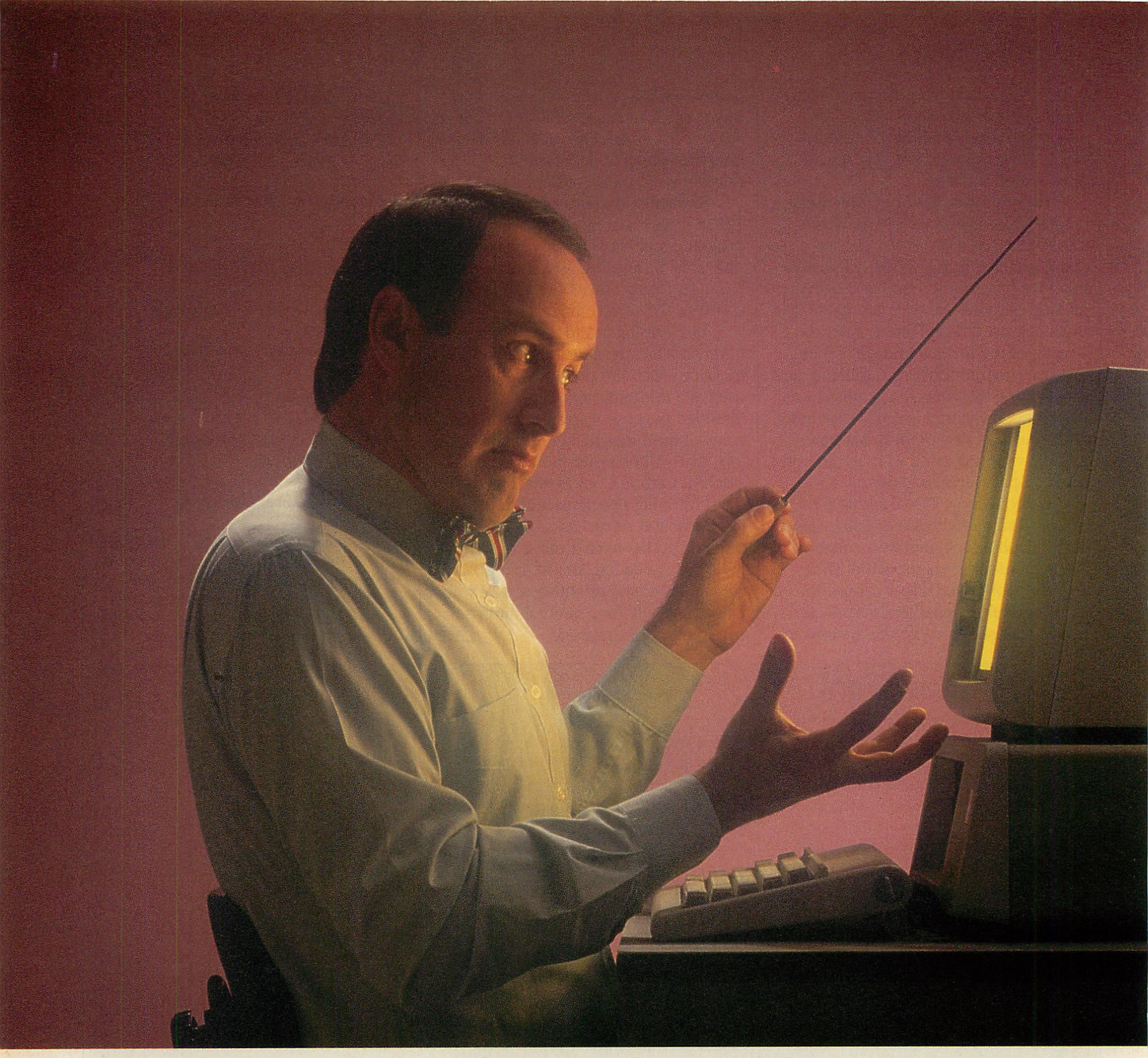
The details of the proprietary closed loop file transfer protocol are not divulged in the LYNC documentation. It is good at detecting errors and recovering from them by retransmission of corrupted data packets. An on-the-fly data encryption and decryption scheme is handy for keeping private data private. Both parties to the transfer must know the appropriate code words (user assignable) for the encrypted transfers to work successfully. Sets of files may be transferred with a single command because LYNC supports the formation of ambiguous file names using the ? and * wild-card characters. Traditional XON/XOFF flow control may be used to transfer ASCII text files in both character and block modes, but only one file at a time, as is also the case for XMODEM.

Batch files, similar to those of DOS but using the LYNC command set, may be of any length and complexity. They are run by the DO command and must be prepared using an external editor. LYNC does not provide a built-in editor. The Hayes Smartmodem command protocol is the paradigm used for all autodial and automated log-in scripts.

LYNC allows the expected control over configuration and initialization of the communications channel, including parity, duplex selection, and speed. The parity setting seems automatically to set the number of data and stop bits in a transmitted character code. Data encryption and packet verification may be toggled on and off independently. Data may be captured to a memory buffer or directly to disk, and filtering may be applied to the incoming data stream to pass or block control characters.

LYNC does not have any video terminal emulation, so its usefulness with many minicomputer and mainframe programs is limited. For its intended purposes and target audiences, however, LYNC is a dependable and capable program.

—*AH*



Carbon Copy lets you pla

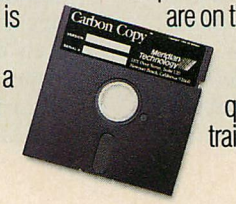
For all you virtuosos who've been searching for the best way to run PCs remotely, your search is over. Thanks to Meridian Technology's Carbon Copy.™ The ultimate software tool for instantly connecting your PC to any other PC.

Carbon Copy is a remote control program for IBM PCs, XTs, ATs, and compatibles. It lets you use your local PC to control and monitor a remote PC over a communications link. And once you're connected, you can run any program you wish: application programs, hardware or software diagnostics, utilities, you name it.

When Carbon Copy links the two PCs, their screens, keyboards, printers and disk drives act literally as one. A keystroke entered on one is displayed on the other. Simultaneously. It's almost like living in stereo. Or being two places at the same time. In fact, the only thing you can do to your local PC that you can't do on the remote PC is change a floppy disk.

With Carbon Copy running as a background task on both PCs, you can monitor a program running on another PC. You can run a program locally to diagnose a problem at the other end. You can even install new software at remote sites from your office PC. All without ever leaving your chair.

In major corporations, for example, Carbon Copy lets the support and training department personnel see what the problems are on the other end. Instantly. And show the user how to fix them just as fast. While he asks and answers questions, and works with the training staff in real time.





y any program in stereo.

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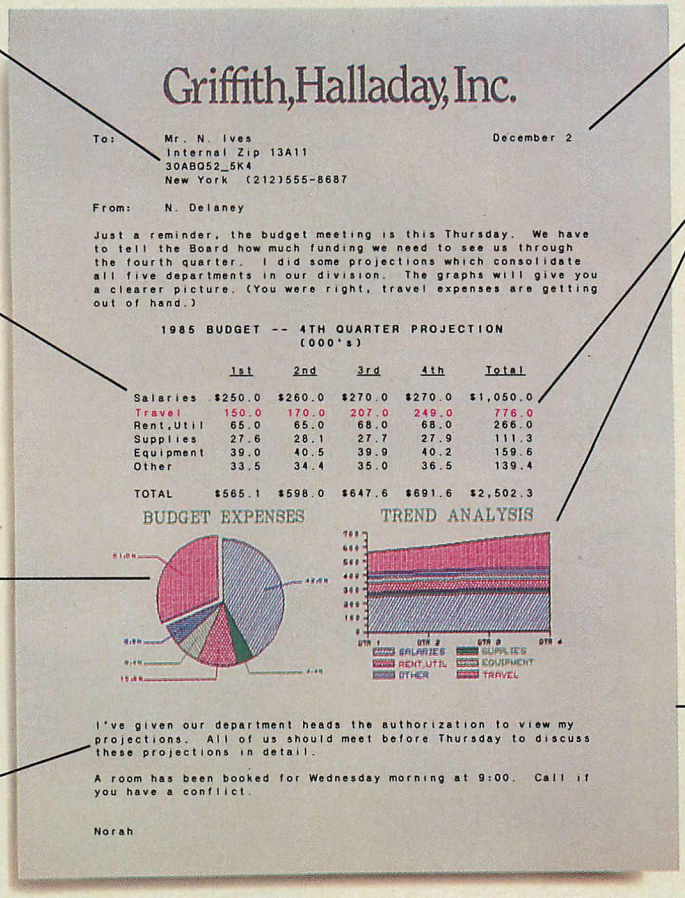
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30ABQ52_5K4
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December 2

From: N. Delaney

Just a reminder, the budget meeting is this Thursday. We have to tell the Board how much funding we need to see us through the fourth quarter. I did some projections which consolidate all five departments in our division. The graphs will give you a clearer picture. (You were right, travel expenses are getting out of hand.)

1985 BUDGET -- 4TH QUARTER PROJECTION
(000's)

	1st	2nd	3rd	4th	Total
Salaries	$250.0	$260.0	$270.0	$270.0	$1,050.0
Travel	150.0	170.0	207.0	249.0	776.0
Rent,Util	65.0	65.0	68.0	68.0	266.0
Supplies	27.6	28.1	27.7	27.9	111.3
Equipment	39.0	40.5	39.9	40.2	159.6
Other	33.5	34.4	35.0	36.5	139.4
TOTAL	$565.1	$598.0	$647.6	$691.6	$2,502.3

BUDGET EXPENSES

TREND ANALYSIS

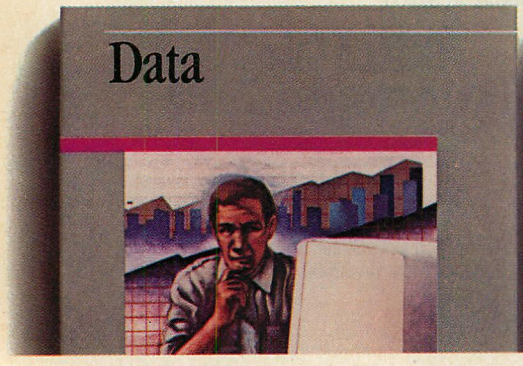
I've given our department heads the authorization to view my projections. All of us should meet before Thursday to discuss these projections in detail.

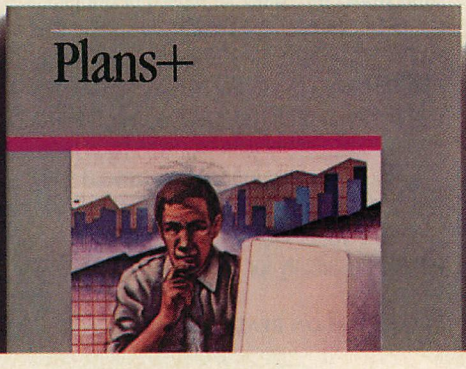
A room has been booked for Wednesday morning at 9:00. Call if you have a conflict.

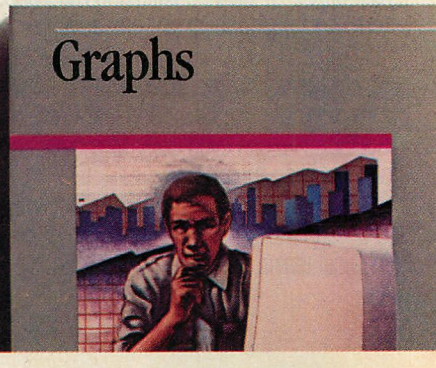
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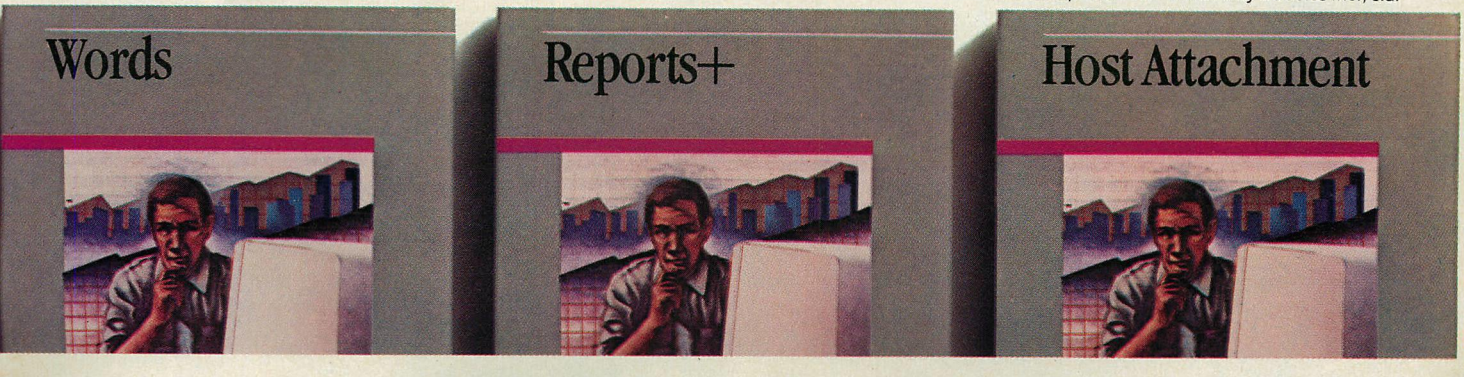
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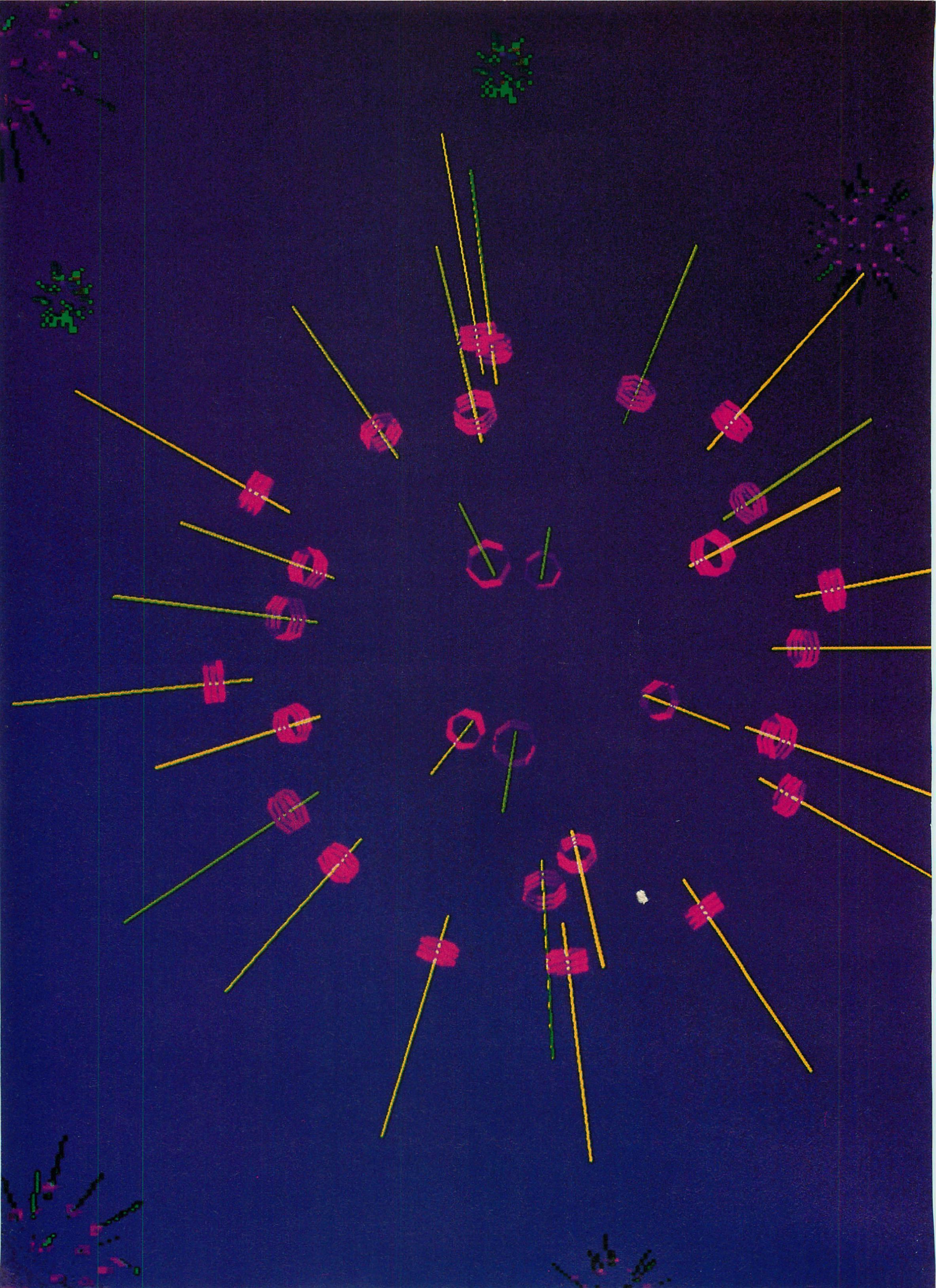
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Decision Series.

Little Tramp character licensed by Bubbles Inc., s.a.





Preemptive Scheduling on DOS

AMX86 meets all the requirements needed to build a lean, dedicated realtime system.

RICHARD M. FOARD

A lone PC sits deep in the bowels of an unmanned plastics factory among chemical vats and a labyrinth of pipes, monitoring dozens of temperature and pressure sensors and reporting via modem to a production supervisor's terminal several miles away. Plant status reports appear on the printer every minute on the minute, and the PC logs a continuous stream of data to a hard-disk file.

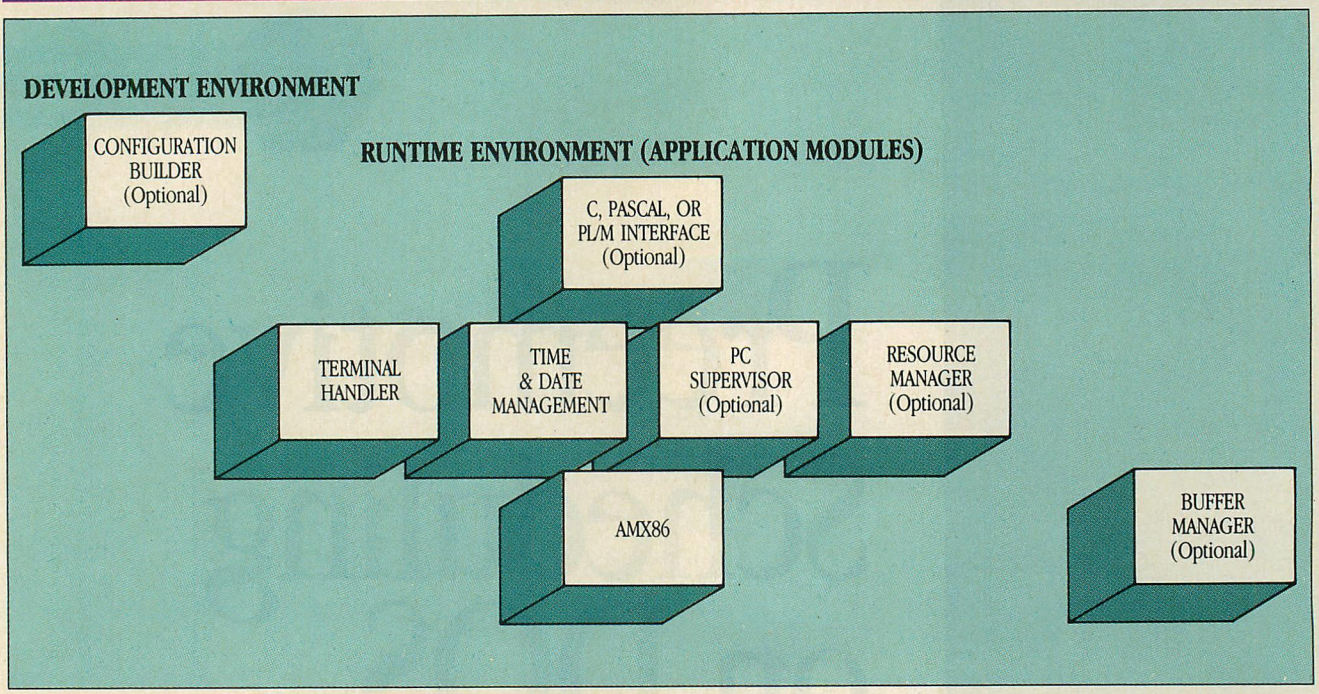
Suddenly, amid all the reporting, communicating, and logging, pressure increases above the danger threshold in the main pipe. Within milliseconds, the PC closes the main valve, sounds an alarm, and telephones an emergency service, all without missing a beat in its monitoring and reporting.

A realtime system is responsible for enabling this fictional PC to keep the world safe from tons of molten plastic. Such a system must be capable of quick response to many external events because it is able to operate many devices concurrently. This second part of a series of articles on realtime systems examines a multitasking software package that provides the support required by builders of realtime systems such as the one described above.

AMX86, by KADAK Products, Ltd., builds dedicated, realtime applications systems on Intel 8088 or 8086-based computers. It is a member of a product family that includes realtime systems for the Motorola 6809 and 68000, Intel 8085, and Zilog Z80 processors.

COMPUTER GRAPHICS • DOV JACOBSON

FIGURE 1: *AMX86 Components*



AMX86 is modular in form. Most applications will be easier to implement by using the optional modules. For example, the PC Supervisor module provides access to more of the DOS functions than the Terminal Handler provided with the basic package.

With AMX86, a user builds a system by coding application tasks and interrupt service modules, composing a system parameters module, and linking these together with the AMX modules that are required by the application. The resulting executable file contains an entire multitasking system.

When executed, AMX establishes a preemptive, priority-based multitasking environment in which it coordinates the execution of user tasks, interrupt service procedures, and timer procedures. User tasks and interrupt procedures can avail themselves of AMX's services for synchronization, timing, and queue management and, optionally, for resource management, dynamic memory allocation, DOS mediation, and concurrent, interrupt-driven I/O. AMX systems can be constructed in assembly language or, if one of KADAK's optional language interface modules is included, in C, Pascal, or Intel's PL/M. The AMX environment and its components are shown schematically in figure 1.

Although it can coexist with DOS on IBM PCs, AMX is not dependent on the particular hardware configuration of the PC, nor does it require the services of DOS in order to operate. It supports Intel's medium, large, or mixed medium and large models of computation. If DOS's services are required, the simple Terminal Handler module supplied with the AMX package can handle minimal needs; more extensive DOS services require the optional PC Supervisor module, available for $250.

SYSTEM PARAMETERS SEGMENT

The first step in building an AMX-based system is the specification of its software configuration—the arrangement of tasks, data queues, timers, buffer pools, and so forth that meet an application's requirements. Once a designer has selected a software configuration, it is encoded in machine-readable form by constructing an assembly language *system parameters module*. The module, the data of which reside in their own segment, guides the operation of AMX through system initialization and throughout execution of the system.

The key data structure in the parameter segment is the task definition table (TDT), which identifies all the system's tasks and defines their characteristics. A task's entry in the TDT, along with its stack, constitute its context for multitasking purposes. As many as 100 tasks may be defined in the TDT. The order in which entries appear determines task priorities; the earlier a task's entry appears in the table, the higher its priority is. Each task's 32-byte entry in the TDT contains (far) pointers to its stack segment and to the beginning of its executable code. The TDT also specifies, for each task, the size of each set of prioritized input message queues.

The parameter segment also contains a list of application-specific restart procedures. Once a system is loaded into memory, AMX starts it running by first calling each of its restart procedures, then giving control over to its task scheduler and allowing multitasking to begin. The restart procedures can initialize shared data structures, start devices, set timers, and execute other start-up activities that must be performed before tasks begin running.

AMX always runs the highest priority task capable of executing. Its task scheduling is preemptive, meaning that if a higher priority task becomes ready to run (as a result of interrupt processing) while a lower priority task is executing, the lower priority task is immediately suspended so that the higher priority task can be given control.

AMX's priority-based, preemptive scheduling discipline allows a system designer to ensure that important events get the quickest possible attention. In settings such as the plastics factory described above, preemptive scheduling allows a designer to handle critical conditions by creating a high-priority task to process them. As soon as the system receives an interrupt signaling that an event requires immediate attention, it starts the task directly from the interrupt service routine. The scheduling discipline then ensures that the task will start running immediately

upon dismissal of the interrupt and retain control of the processor (except for other interrupt processing) until the emergency has been handled. A nonpreemptive system would receive the interrupt, signal the emergency task, but then continue performing routine processing chores for an unpredictable amount of time before allowing the emergency task to run.

Along with increased system responsiveness, preemptive scheduling brings a more stringent set of design rules. The designer must ensure that each task executes correctly even though higher priority tasks may execute between any two instructions. He must remain watchful for segments of code that must be protected from interruption by higher priority tasks. If a task must adjust a multipart data structure that is periodically examined by higher priority tasks, for example, the system must prevent tasks from inspecting the data structure while it is adjusting. This can be accomplished by coding the lower priority task to disable interrupts while adjusting the data or by introducing a mutual exclusion mechanism that causes a task attempting to inspect a partly adjusted data structure to suspend until the adjustment is complete.

AMX provides a well-crafted variety of intertask communications and synchronization facilities. A summary of these AMX86 services is shown in table 1.

Its simplest mechanism is the AATASK (start task) call, which allows one task to start another. AATASK marks the indicated task as ready to run or, if it is already running, notes that it has been started so that it will be restarted when it later attempts to stop. When rescheduling occurs at the next interrupt, the highest priority task will run. If this delay between the task being marked and the task actually running is unacceptable, the calling task may explicitly allow an immediate context switch by calling the service routine AASHED (force rescheduling).

The AACALL (call task) service routine performs the same function as AATASK, but allows its caller to pass a 12-byte parameter block to the called task. The caller specifies which of the called task's four input data queues is to receive the parameters.

The task scheduler activates a started or called task when the task's turn to execute arrives by performing a far call to its starting address. If the task is being activated because it was called (AACALL) with parameters on one of its input queues, the scheduler copies a parameter block from the highest priority (nonempty) input queue into the task's stack and leaves the BP register pointing to the block before executing the far call. When a task has finished its processing, it returns control to the task scheduler by executing a far return instruction or by calling the service routine AAEND (end task).

TABLE 1: *Basic AMX86 Services*

SERVICE	FUNCTION
AATASK	Start a task
AACALL	Start a task, sending it a message at some priority between 0 (high) and 3 (low); then, optionally wait for it to execute
AAWAIT	Wait unconditionally for an event
AAWATM	Wait for *N* system ticks or an event
AAWAKE	Wake up a particular task if it is waiting (AAWAIT or AAWATM)
AAWAKC	Wake up calling task if it is waiting in conjunction with an AACALL
AAEND	End execution of the current task
AASHED	Unconditionally force task rescheduling
AATPUT	Start a timer
AATOFF	Stop a timer
AATGET	Get the value of a timer
AAGETN	Get current task number
AAGTCB	Get address of a task control block
AAIPTR	Install interrupt vector
AARSTL	Reset a list
AAATL	Add to top of list
AAABL	Add to bottom of list
AARTL	Remove from top of list
AARBL	Remove from bottom of list

The service routines in the Terminal Handler module of AMX86 do not depend on DOS to run. The timing routines require the presence of a hardware realtime clock and the inclusion of a special timer task module.

The AACALL service routine provides an option not available to callers of AATASK: the calling task may indicate that it wishes to be suspended until the called task has finished processing its request. The called task need not take any special action in this case—AMX handles the suspension and later reactivation of the calling task automatically. The called task is given the option, however, of indicating that its caller should be allowed to resume execution *before* the called task has terminated; it accomplishes this by calling the service routine AAWAKC (wake caller).

AACALL can be used in this synchronized mode of operation to solve a number of frequently occurring design problems. Many tasks, for example, may have to contend for a resource that can serve only one task at a time, such as a printer. Furthermore, some or all of the contending tasks may need to use the resource before they can proceed. The designer can use the AACALL service to meet this requirement neatly, by dedicating a single task to the function of using the resource and coding all the other tasks to call upon it, using AACALL's synchronized mode, whenever they require use of the resource.

Restart procedures, tasks, and interrupt service routines may use AATASK and AACALL to start tasks.

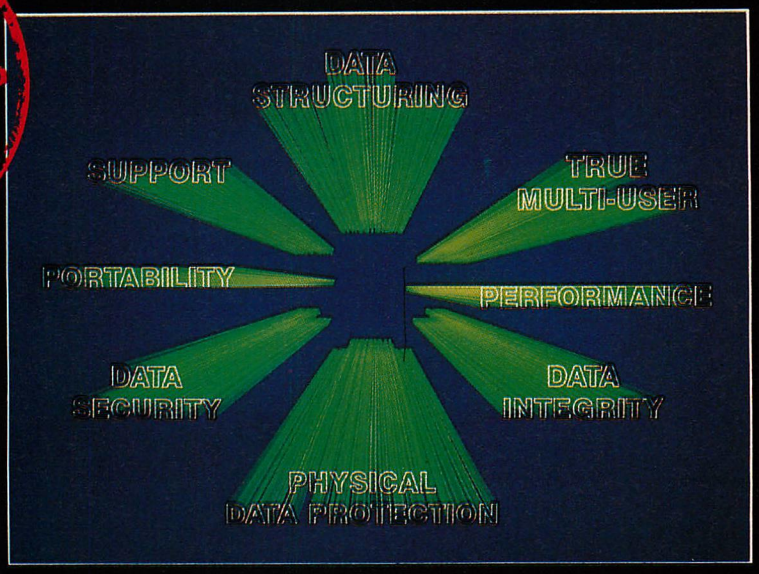
EVENT SYNCHRONIZATION

AMX provides a synchronization mechanism that allows a task to wait for some event to occur. Calling AAWAIT causes a task to be suspended until later awakened via a call to AAWAKE from elsewhere in the system. Using this mechanism requires some care because a call to AAWAKE takes effect only if the task to be awakened has already called AAWAIT; attempts to awaken a nonsleeping task result in an error code being returned to AAWAKE's caller. The designer must somehow ensure that waits and wakes occur in the correct time order. In a busy realtime environment in which many tasks are asynchronously going about their business, this is not always easy to accomplish.

A common scenario for managing an input device goes as follows: a task responsible for operating the device issues I/O, then calls AAWAIT; the device develops input data, then performs interrupts to signal that the data are ready. An interrupt service routine reads the input data and calls AAWAKE to signal that the operation is complete and the data are ready.

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The realtime pitfall looming here is that the task may suspend after starting the device but before issuing its call to AAWAIT and remain suspended until after the device has interrupted and the interrupt service routine has called AAWAKE. When the task that started all this finally does get around to calling AAWAIT, it has already missed the event for which it was trying to wait. The interrupt service routine, in the meantime, has been notified that its call to AAWAKE failed because the indicated task was not sleeping.

Realtime system designers must consider the possibility of such accidents of timing, even if their occurrence is unlikely. An ability to anticipate and provide for all possible configurations of input events is essential for any successful realtime design.

Under AMX, one approach to resolving this device management problem would be to code the input task to disable interrupts before starting the input device, ensuring that the task will have an opportunity to call AAWAIT before the device interrupts (AAWAIT enables interrupts after suspending the calling task). Although effective, this solution is a little heavy-handed—disabling interrupts should be avoided in a realtime system unless the designer has no alternative, because it reduces the system's responsiveness to external events. A better choice might be to code the input task so that it expects to receive its data from the interrupt service routine via AMX's AACALL facility for starting a task with queued parameters. Unlike AAWAIT and AAWAKE, the AACALL mechanism has "memory"—in other words, the called task is not allowed to forget that it was called if it was away at the time a call occurred.

AMX provides a variant of AAWAIT that allows a task to wait either for an event to occur or for a time limit to expire, whichever occurs first. A task wishing to perform this either/or style of wait calls the service routine AAWATM (timed wait). When control is returned from AAWATM, the calling task receives indication of the reason it was awakened (timer or event occurrence).

This timed wait capability of AMX addresses a requirement that arises often in multitasking system design—the need to handle runaway or locked up I/O devices. Usually, the procedure for managing interrupt-based devices entails starting the device, then waiting for a signal from an interrupt service routine indicating that the device has interrupted the processor upon completing its operation. Before signaling the calling task that the interrupt has occurred, the interrupt service routine typically queries the device's status to determine whether or not the operation was successful; in the event of an error, it may even retry the operation.

One very important possibility is ignored in the procedure as sketched above, however: the possibility that the device malfunctions in such a way that it never interrupts at all. This is a costly oversight because it can allow a transient device failure to bring an entire system grinding to a halt.

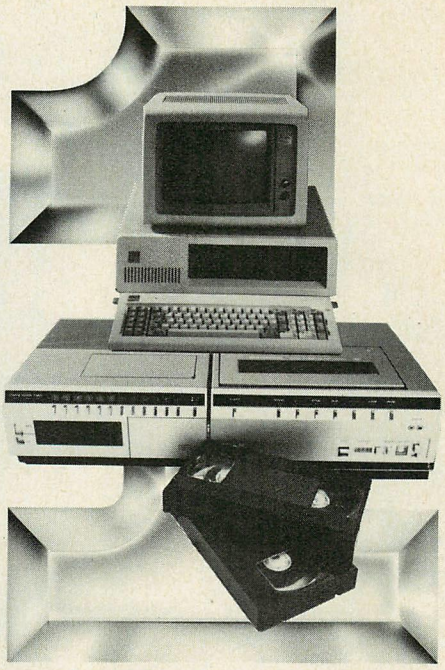
AMX's AAWATM call provides a neat, succinct way for tasks to remain watchful for these device time-out situations. By calling AAWATM instead of AAWAIT to await a device's completion interrupt, a task can quickly determine if it was awakened by normal I/O completion or by the expiration of the timer. In the event of a device time-out, the task can attempt to drive the wayward device back into a known state by issuing reset instructions, then retry the operation. Even if attempts to shake sense back into the device fail, knowledge of the failure is preferable to ignorance because the system can go on to notify system operators, engage in a graceful degradation procedure, or take other appropriate action.

An ability to anticipate and provide for all possible configurations of input events is essential for successful realtime design.

The use of timed waits is not limited to the area of I/O device management. Any task that wishes to wait with limited patience for an event to occur can use the AAWATM service call.

Tasks can use AMX's interval timing facilities in one of two ways. They can use AAWATM to perform timed wait operations or they can explicitly set interval timers using the AATPUT (put timer) service call. A task passes AATPUT the address of a timer procedure and a 16-bit countdown timer value specifying the desired delay (in clock ticks) before the procedure is executed.

When a timer fires (its countdown value reaches 0), AMX calls the timer's associated procedure. Timer procedures do not themselves run as part of a task,



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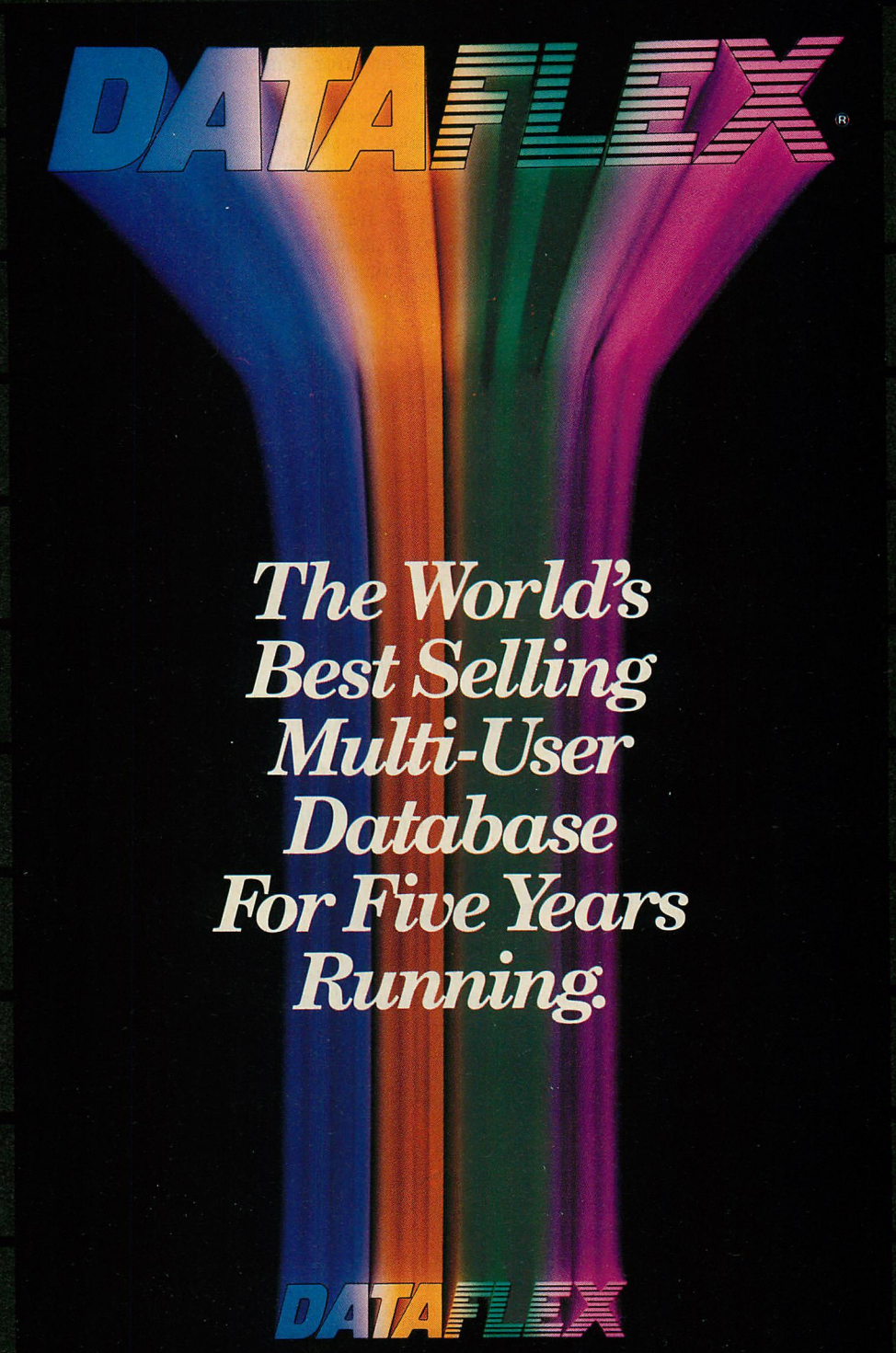
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but they may call upon all system services not reserved for tasks only. They may set other timers, awaken waiting tasks, start or call tasks, and so on.

Two other routines are provided as part of the general purpose interval timing facility. AATGET allows its caller to read the value of a timer as it counts down toward completion; the AATOFF routine cancels a timer.

The operation of AMX's timing services requires a hardware realtime clock and the inclusion of a special timer task (supplied with AMX) and a user-supplied clock interrupt service routine. This routine must perform any action necessary to keep the realtime clock ticking, then execute a far call to the AMX-supplied routine AACLK. AACLK starts the timer task whenever the clock interrupts. The timer task, which must run as the system's highest priority task, performs all processing necessary to advance or fire active timers, then terminates.

INTERRUPT PROCESSING

AMX provides a powerful and flexible context in which users may construct interrupt service routines. User programs may use the routine AAIPTR (install interrupt pointer) to install the address of their interrupt service routine in the processor's interrupt vector. AAIPTR permanently installs the user's routine unless it is for interrupt types 0 (divide error) or 4 (overflow), in which case the address is stored in association with the calling task. Under AMX, each task may provide its own handlers for divide and overflow errors.

When setting up a system's parameters, the user must create and allocate space for an interrupt stack segment. All interrupt processing is performed using this stack. This approach to meeting interrupt processors' storage requirements is superior to that taken by simpler operating systems that allow interrupt processors to use the stack of whichever task is running at the time an interrupt occurs. It simplifies the designer's job of determining the amount of stack space to allocate for each task, because it removes the need to add enough space to meet the requirements of deeply nested interrupt processors to every task's stack.

A user codes an AMX interrupt service routine with the help of two AMX-supplied routines: AAINT and AAINX. An interrupt routine must call AAINT at the beginning, perform all processing required by the device, then call AAINX before terminating with an IRET instruction. AAINT switches to the interrupt stack, saves all registers, and returns to the user's service routine with the code segment set to the interrupt processor's code segment and the data segment set to the interrupt stack segment.

The user's device-dependent code in the body of the interrupt service routine may call upon AMX service routines to start timers and signal or start tasks in addition to performing device service. It may also enable interrupts if nested interrupt processing is required. When its service is complete, the user routine calls AAINX. AAINX examines AMX's state to determine which of three actions to take. If the interrupt just processed was nested inside another interrupt, it simply restores registers. If a user task was running when the interrupt occurred, AAINX determines whether the interrupt service routine may have readied (via AACALL, AATASK, or AAWAIT) a higher priority task for execution. If so, it suspends the interrupted task and invokes the task scheduler. If not, the interrupted task's registers and stack are restored and it is allowed to resume execution.

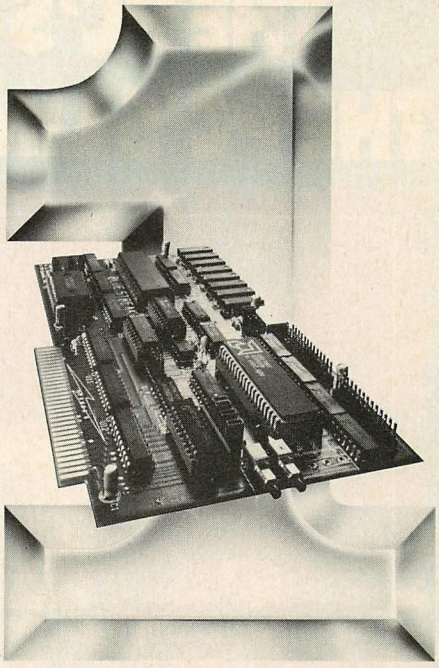
AMX's preemptive scheduling discipline is realized in its complement of interrupt processing support routines. In addition to allowing AMX to offer preemptive scheduling, the services of AAINT and AAINX remove much of the error-prone drudgery from the process of coding interrupt service routines.

ADDITIONAL SERVICES

AMX provides four queue management routines that may be called upon by user code. They manage queues of 1-, 2-, or 4-byte data items, allowing insertion or removal of items at either the beginning or the end of a queue. All operations are properly protected from untimely (midoperation) interruption, yet preserve the caller's interrupt state (interrupts on or off).

The basic AMX package includes a time-and-date-services module that may, at the user's option, be included in the system. If it is present in a system, the time-and-date module allows user tasks to set the time of day, query it, and format it into an ASCII string in one of a variety of forms.

The time-and-date module uses AMX's interval timing facilities to gain control of the processor one time per second. While the module has control, it updates the time of day, then, if configured to do so, calls a user-supplied routine. The user's routine has an opportunity to inspect the current time of day and trigger any desired time-of-day-based activities.



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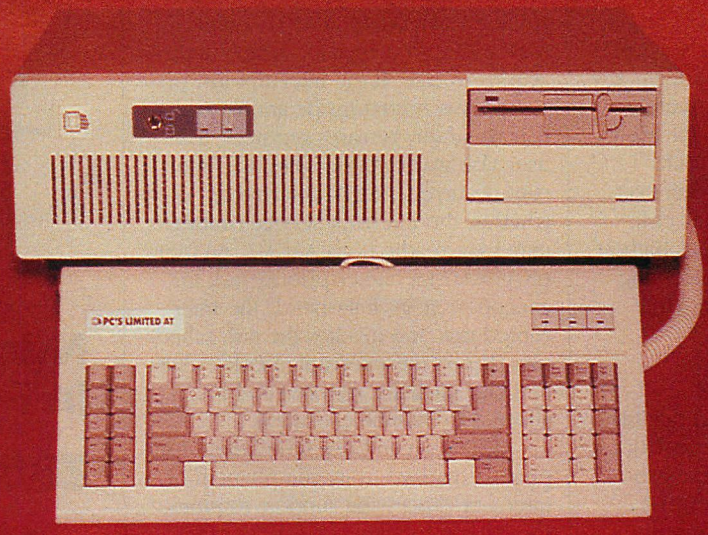
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A Resource Manager module that extends AMX's task synchronization facilities is available to users as an extra-cost option. Its name suggests a function slightly more general than the module actually performs—it allows a task to use one of a set of resources by excluding all other tasks.

The user must set up a table identifying each resource that is to be controlled and specifying a maximum queuing depth for each. When the system is in operation, a task requests the use of a resource by calling AARSRV (reserve resource) and passing a number identifying the desired resource. If the resource is free, the task is awarded ownership and allowed to proceed. If it is owned by some other task, the requesting task is placed in a FIFO queue of waiting tasks unless the resource's queue is full, in which case the requesting task is passed a failure code and allowed to proceed immediately.

The use count mechanism may seem peculiar—the notion of the same program using a buffer twice at the same time is a strange one.

Having gained control of a resource, a task is permitted to make undisturbed use of it until it calls AARELS (release resource), at which time the next waiting task is given ownership of the resource and allowed to proceed.

The Resource Manager is limited to managing single-user resources. Its facilities are not useful for controlling pools of resources that can serve more than one task at a time. Given a pool containing three large buffers, for example, the designer must build his own mechanism for parceling buffers out to contending tasks.

AMX's Buffer Manager, another extra-cost option, is unlike the Resource Manager in that it does not require the AMX kernel; it can be used in standalone systems or those based on other operating systems as easily as it can be used under AMX.

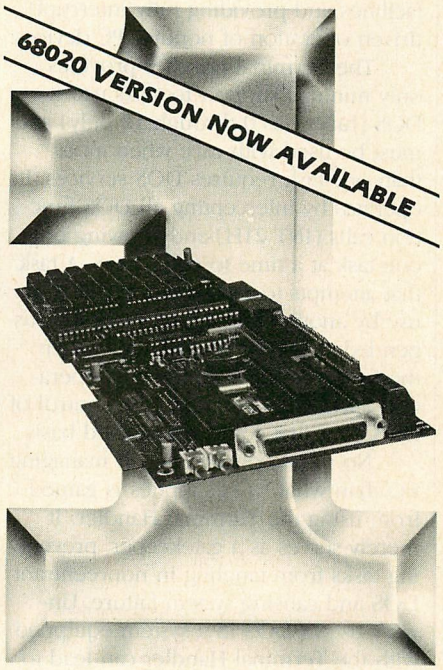
The Buffer Manager requires the user to reserve RAM storage for the required number of buffer pools and create a pool description table giving the size and number of buffers in each pool. Once a pool or a set of pools has been established, user programs may request and release buffers at will.

The mechanism maintains a *use count* for each buffer that begins at 1 when a buffer is allocated and may be explicitly incremented by the owning program. Each time a buffer is released, its use count is decremented by 1; when the count reaches 0, the buffer is returned to the pool. The use count mechanism may seem a little peculiar at first glance—the notion of the same program using a buffer twice at the same time is a strange one. It makes more sense in a multitasking environment, however. A system designer might, for example, want to fill a buffer with data, increment its use count to 2, then pass its address to two other tasks. Each of the receiving tasks receives the buffer's address and processes its data, then releases the buffer. The use-count mechanism ensures that the buffer is not returned to the pool until the slower of the tasks is finished with it.

The Buffer Manager has no synchronization capabilities. A task that tries to allocate a buffer from a pool must be prepared to deal with failure (pool exhausted) unless an always-adequate buffer supply is ensured at higher levels of system design. In contrast, many memory management packages are able to queue up requesting tasks when a pool is empty. The absence of this capability, although it uncouples the package from any particular operating system's synchronization scheme, saddles the designer with the responsibility of building his own synchronization code if required.

WITH OR WITHOUT DOS

AMX-based systems can be configured to run with or without DOS. A designer who wishes to make use of DOS's services can choose between two KADAK-supplied interface methods. The simpler of the two, implemented in the Terminal Handler module, comes as part of the standard AMX package. It allows AMX tasks to call DOS for input and output to the system display, keyboard, printer, and serial communications adapters. Function provided by the Terminal Handler is limited; its management of printers and serial communications ports is *not* interrupt-driven, and it does *not* allow use of the DOS file system. AMX's more sophisticated level of DOS support, the PC Supervisor package, is available as an extra-cost option. The PC Supervisor provides a much richer set of functions than the Terminal Handler, allowing the use of DOS's disk and file management



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facilities and providing fully interrupt-driven operation of nondisk PC devices.

The Terminal Handler provides only minimal support to tasks using DOS (functions 0 through 12 only) and must be used with care when more than one task requires DOS services. It operates by intercepting all DOS function calls (INT 21H) and allowing only one task at a time to enter DOS. A task that attempts to call DOS when it is in use by another task is automatically suspended; it is reawakened later, when the first task has completed its operation and left DOS. Tasks gain control of DOS on a first-come, first-served basis.

No more concurrency in managing I/O than what DOS supplies is gained from using the Terminal Handler. It merely serves as a gatekeeper, preventing tasks from tangling in nonreentrant DOS and causing system failure. Unwary use of DOS in a system equipped with the Terminal Handler can lead to unusual realtime behavior. If one task calls DOS to write a line to the printer, a second task wishing to read a character from a serial port is suspended until the line has printed (regardless of the tasks' relative priorities).

The optional PC Supervisor module is a practical necessity in almost all realtime applications. Unlike the Terminal Handler, the PC Supervisor provides access to the DOS file system and allows fully concurrent, interrupt-driven I/O to the PC's devices.

Like the Terminal Handler, the PC Supervisor serves as a DOS traffic cop, managing the system as a single-user, serially reusable resource. The PC Supervisor, however, requires that tasks explicitly call for control of DOS before making a function call and explicitly release control afterwards. This creates another rule that applications programmers must follow, but it gives them greater flexibility in managing DOS. For example, a task could gain control of DOS, then make several function calls before releasing it; in this way, no intervening DOS operations can be performed by other tasks. Such arrangements are impossible to construct under the Terminal Handler because it automatically releases DOS after each function call. Under the PC Supervisor, as under the Terminal Handler, task priorities are ignored when tasks contend for use of DOS. When a task releases DOS, control is awarded to the task that has been waiting the longest.

The PC Supervisor provides fully interrupt-driven I/O by including its own drivers for serial ports, printers, and keyboard. User tasks employ these drivers by making standard PC BIOS calls. The calls are intercepted by AMX and directed to AMX's drivers, which present interfaces identical to those of the BIOS routines they replace (BIOS calls that operate on noninterrupting devices, such as the VIDEO_IO (INT 10H) call, are not intercepted). Table 2 shows the standard IBM PC hardware and software interrupts and indicates how they are processed under AMX.

TABLE 2: *PC Supervisor Interrupt Processing*

INTERRUPT	FUNCTION	SERVICED BY
0	Divide by 0	AMX—user task
1	8086 single step	IBM debugger
2	Nonmaskable interrupt	BIOS
3	Breakpoint instruction	IBM debugger
4	Overflow	AMX—user task
5	Print screen	(ignored by PCS)
6	(Reserved)	——
7	(Reserved)	——
8	Timer 0 (clock) interrupt	PCS
9	Keyboard interrupt	PCS
A	(Reserved)	——
B	Serial port #2 interrupt	PCS
C	Serial port #1 interrupt	PCS
D	Fixed disk interrupt	BIOS
E	Floppy disk interrupt	BIOS
F	Printer interrupt	PCS
10	Video I/O call	BIOS
11	Equipment check call	BIOS
12	Memory check call	BIOS
13	Disk I/O call	BIOS
14	Serial port I/O call	PCS
15	Cassette I/O call	(ignored by PCS)
16	Keyboard I/O call	PCS
17	Printer I/O call	PCS
18	ROM BASIC entry	(ignored by PCS)
19	Bootstrap loader	PCS
1A	Time-of-day call	PCS
1B	Keyboard Ctrl-Break	BIOS or DOS/User
1C	Timer tick	(not generated by PCS)
1D	(Video table)	——
1E	(Diskette parameters)	——
1F	(Graphics table)	——
20	DOS terminate program	PCS
21	DOS function call	PCS—DOS
22	DOS terminate address	User
23	DOS Ctrl-Break handler	User
24	DOS critical error handler	PCS—user
25	DOS absolute disk read	DOS
26	DOS absolute disk write	DOS
27	DOS terminate and stay resident	PCS

The Terminal Handler module that is supplied as standard with the AMX86 package provides access to the DOS function calls 0 through 12 only, while the optional PC Supervisor allows access to the DOS file system.

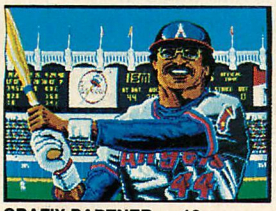
The PC Supervisor's device drivers initialize PC hardware to a configuration slightly different than that established by the standard IBM BIOS. Timer 0 of the 8253 timer/counter device is initialized to interrupt with a frequency of 20 Hz instead of the standard 18.2-Hz rate. AMX also rotates the 8259's interrupt priorities to give the Asynchronous Communications Adapters the two highest interrupt priorities, thereby overrid-

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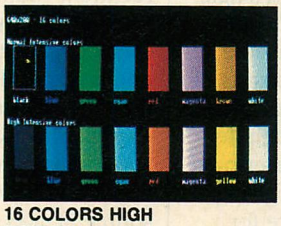
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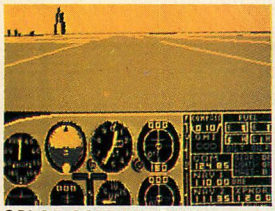
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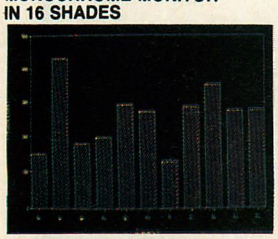
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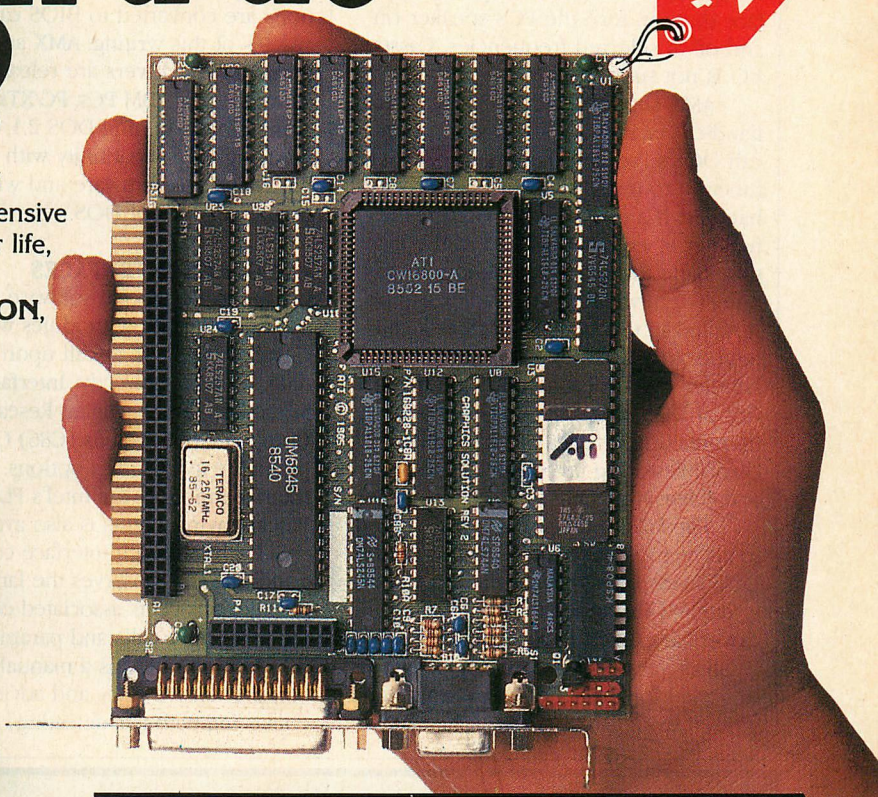
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ing the BIOS-established priority ordering that places the timer and keyboard interrupts above those of the communications adapters.

In addition to providing controlled access to DOS and concurrent I/O, the PC Supervisor includes a speaker interface that can turn the PC's speaker on and off at selected frequencies. Cassette I/O is not supported.

AMX supports DOS's "critical error handler" facility. An AMX system may call DOS's "set interrupt vector" (25H) function to install its own critical error handler. If a critical error occurs, the handler is executed as part of the task that made the DOS call. Although only one system-wide error handler can be installed in this way, an AMX task can temporarily install its own specific error handler by requesting and gaining control of DOS, installing its own handler, then making a series of DOS calls before restoring the original handler and releasing DOS.

The PC Supervisor is not designed to allow modules written to run under DOS to execute without modification under AMX's mediation. Because its drivers are functionally identical to BIOS drivers, however, many programs designed for the DOS environment and written using BIOS calls can be converted to run in the concurrent AMX environment. For that matter, DOS programs that perform device I/O using DOS calls also can be easily converted, but will not enjoy the benefits of concurrent I/O unless DOS calls for keyboard, printer, and serial communications are converted to BIOS calls.

As of this writing, AMX and its optional device drivers are released and supported for IBM PCs, PC/XTs, and compatibles running DOS 2.1. KADAK is verifying its compatibility with the AT's hardware and firmware and with more recent versions of DOS.

LANGUAGE INTERFACES

KADAK has developed software interface modules that allow modules written in C, Pascal, or PL/M to call upon any of AMX's services directly. Interfaces for Microsoft, Lattice, Digital Research, and Computer Innovations (C86) C compilers are available as options. A single interface module for Intel's PL/M and Pascal environments is also available.

Each language interface consists of a module that observes the large-model conventions of its associated compiler for procedure calls and parameter passing. Also provided is a manual giving comprehensive rules and advice for coexisting with (or defeating) the compiler's segmentation, stack checking, and global name construction rules.

Coding an AMX-based application in C is convenient, but requires that the developer do a little more than simply replace assembly language code with C. He must observe AMX's recommended settings for compiler option switches to select large memory model and disable stack overflow checking. Most C compilers, by default, generate code to test for stack overflow at the beginning of each procedure. Under the stack-switching AMX environment, however, these tests are invalid and cause false indication of stack overflow.

The high-level language developer must also keep reentrancy in mind when writing code to run under AMX. The Microsoft C compiler, for example, generates reentrant, ROM-able code, but its runtime library includes routines that are not reentrant. To use non-reentrant routines such as those in Microsoft's dynamic memory allocator (**malloc**, **calloc**, etc.) from more than one task, the developer must ensure that one task at a time calls upon them. This can be accomplished only at the applications level, by bracketing calls to the allocator with calls to AMX's Resource Manager or some equivalent mutual exclusion mechanism.

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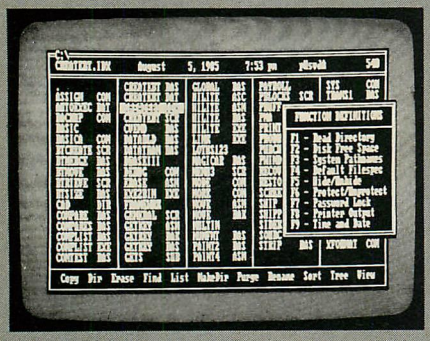
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TABLE 3: *System Configuration*

CONFIGURATION PARAMETERS FOR SYSTEM WITH TITLE
(Example AMX system configuration)

TASK #	TASK NAME	TASK ADDR	TASK STACK	TASK MODEL	TASK ATT.	QUEUE DEPTH LEV0	LEV1	LEV2	LEV3
0	TMR	AMTMRT	128	LARGE	0	0	0	0	0
1	CONI	CONSIN	1,024	LARGE	0	0	0	0	0
2	PRTO	PRTOUT	512	LARGE	0	8	8	8	8
3	SENS	SENSOR	1,024	LARGE	0	8	4	4	2
4	APPL	APLTSK	1,024	LARGE	0	8	8	8	8

RESOURCE MANAGER

RESOURCE #	RESOURCE NAME	QUEUE DEPTH
1	PRINTR	5
2	MEMI01	3
3	MEMI02	3
4	ERRWIN	8

BUFFER MANAGER

POOL #	# BUFFERS	SIZE
0	16	64
1	1,024	4

RESTART PROCEDURES

AMTDRR	PRTRST
AMRMRR	CLKRST
AABIA	SENRST
CONRS	GLORST

TIMER AND PROCEDURE ADDRESSES

TIMER	TIMER PROCEDURE
TMTD	AMTDTR
HOURLY	TMHRLY
MIDDAY	TMNOON
PERSEC	TMSEC

Clock frequency in Hz is 20.
Clock ticks per system tick is 1.
Time/date maintenance is included.
Time/date period in system ticks is 20.
User procedure 'TDSCHD' is connected to time/date.

The configuration module provides an output that summarizes the configuration of the particular system that has been generated. The code that AMX86 produces in the parameters module for this particular configuration is shown in listing 1.

In all four supported C environments, some runtime library routines are nonreentrant by virtue of their use of nonsharable DOS calls. C's standard **printf** routine, for example, calls upon DOS to perform output to the terminal and, consequently, cannot be called freely from AMX tasks. Users of the Terminal Handler DOS interface method can rely on the Terminal Handler's transparent interception and queuing of DOS calls to avoid entering DOS from multiple tasks. Users of the PC Supervisor interface method, however, must code tasks to reserve DOS explicitly before calling any runtime routine that may issue a DOS function call.

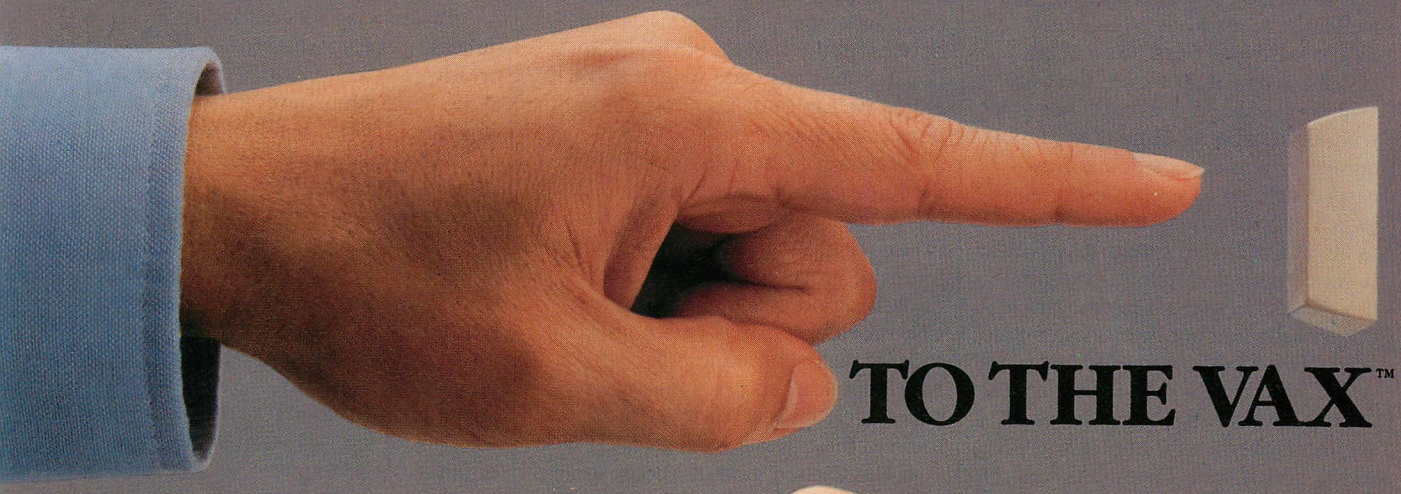
CONFIGURATION BUILDER

Nearly every facility of AMX requires that a parameter table of some sort be set up in preparation for generating a system. Tasks must be defined, in priority order, in a task definition table. Space must be allocated for system input queues. Tables of timer and restart procedure addresses must be established. In systems incorporating the optional Resource or Buffer Manager modules, still other parameters and buffers must be defined.

Although clear instructions are provided for every step of system set-up, the rules are numerous, complex, and interdependent. KADAK provides, as an option, a Configuration Builder program that cuts through most of the complexity. This interactive program quizzes the system builder about the desired configuration. It has built-in knowledge of system composition rules and restrictions and can eliminate tedious and time-consuming mistakes. When its question-and-answer session is done, the Configuration Builder creates an assembly language source program containing all the required parameter tables and segmentation and storage allocation directives. A parameters module for a sample system configuration is shown in listing 1.

The Configuration Builder package also includes a program that can produce a document summarizing a sys-

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C/SHARP: ANOTHER APPROACH

Because the multitasking approach to managing concurrent processing is a well-known, relatively simple technique, it is widely used in realtime systems. It is not, however, the only way to provide concurrency, nor is it without drawbacks. Time that a multitasking system spends doing the record-keeping to keep track of and switch control among tasks is wasted as far as the system's ultimate purpose is concerned. It is spent to simplify the job of the system builder, and it reduces the amount of processor time available for performing the real work of the system. As a rule, the more features a multitasking system provides, the more overhead it imposes. UNIX exacts a high price for multitasking because of the substantially complex and general environment it manages. AMX86, on the other hand, is a lean operating system that runs with minimal overhead.

The Systems Guild's C/Sharp Realtime Toolkit was developed on the premise that many realtime applications can be implemented more efficiently using techniques other than full, general purpose multitasking. It provides five families of subroutines that separately or in combination can tackle realtime jobs.

The Toolkit is comprised of an interrupt service support module, an event tracker, a procedure scheduler, a finite state machine interpreter, and a device-independent graphics package. Written almost entirely in C, the program allows the construction of highly portable systems. The Systems Guild's goal is to support the development of systems that can be moved easily among different processors, C compilers, operating systems, and I/O devices. In the IBM PC environment, C/Sharp supports code written using either the Lattice or Computer Innovations C compilers.

C/Sharp's **Cisr**, like its other four modules, enhances system portability by placing a layer of abstraction between an applications system and the interrupt processing facilities of its underlying processor and software. **Cisr** provides a pair of environment-independent subroutine calls with which applications programs may replace interrupt vectors or restore them to the original contents.

The **Csched** module allows applications to schedule C procedures for execution at specified times in the future. Scheduling is driven by a user-supplied *soft clock pulse*—user code must make a call to the package's **clock** routine at regular intervals. The clocking requirement is usually met by coding a realtime clock interrupt service routine. Each time **clock** is called, **Csched** examines the system's state to determine if a paticular procedure should be started.

Each procedure is scheduled for execution at a priority from 0 (lowest) to 15 (highest). Priorities come into play when a procedure arrives at its scheduled execution time while another procedure is running. If the newly awakened procedure is of higher priority, the running procedure is suspended and the new procedure is allowed to run; execution of the lower priority procedure is then resumed when the higher priority procedure terminates (returns).

By allowing scheduled procedures to preempt those of lower priority, **Csched** provides concurrency at the applications level, beyond that which occurs as a result of interrupt processing. Preemptive scheduling allows **Csched**-based applications to be very responsive to external events. In addition, it requires that procedures executing under **Csched**'s control observe the same rules for protecting critical sections of code from interruption that tasks in a more general priority-based multitasking system are required to follow.

Unlike tasks in a general purpose multitasking system, procedures running under **Csched** may not suspend while lower priority procedures execute. Each must be designed to run to completion in a relatively short time. This design constraint is imposed because **Csched** does not manage a stack for each procedure. All procedures run using a single stack. A procedure that interrupts a lower priority procedure piles its storage on top of the lower priority procedure's and consequently must finish and clear off the stack before the lower priority procedure may resume. A high-priority procedure that runs for too long a time blocks the execution of all equal and lower priority procedures.

The **Cevent** module is a software "black box" to which an application can define a set of events that it is interested in tracking. As soon as the events have been defined, the application may call **Cevent** to announce that

tem's configuration (table 3) and complete Pascal source for the Configuration Builder itself.

MEETS ALL REQUIREMENTS

AMX86 documentation is nothing less than a joy to use. The subject of realtime multitasking systems is a complex one in which details are of paramount importance. Vague, incomplete, or misleading documentation can cost even an experienced developer frustration and tremendous delays in system development and testing. KADAK's documentation is comprehensive and crystal clear. Each system service is documented in a form suitable for quick reference and also detailed in a more extensive narrative description. Written in brief, tutorial form, the narrative descriptions are clear enough to serve as an advanced realtime systems textbook.

The basic AMX86 package, which includes source and relocatable modules for the Multitasking Executive, Time and Date Services, Terminal Handler, and test programs, is available for $950. KADAK's licensing policy allows unlimited distribution of AMX in executable form with no further charges or royalty payments; distribution in source or relocatable form is prohibited.

The optional Resource Manager and Buffer Manager modules are $150 each. The PC Supervisor, Configuration Builder, and C language interfaces are each priced at $250. The PL/M and Pascal interface module is $300.

KADAK provides telephone support at no charge to customers bringing AMX up for the first time. The policy regarding software updates is to distribute source-level repairs for any problems discovered in AMX.

AMX's functional design meets *all* the common requirements of realtime system builders. KADAK's engineers brought the benefit of years of practical, realtime experience to bear on AMX's design. Even a quick glance at the source code (assembly language, Intel mnemonics) gives the reader a feeling for the product's maturity. The code is forthright, compact, and well commented. Each line includes a comment giving its line number. Revisions are each accompanied by an ECN (engineering change notice) number. The ECN numbers, along with the parts numbers embedded in the names of all

an event has occurred, inquire about the recent history of event occurrences, or temporarily disable tracking of a particular event type. The **Cevent** module is useful, for example, in situations where interrupt service routines detect and report events that are of interest to asynchronously executing applications programs.

The **Cstate** package allows applications programs to define and execute in parallel one or more state machines—automatons with defined sets of states that move from state to state based on input events and perform a prescribed set of actions (encoded in C procedures) each time a state transition occurs.

In realtime settings in which a system's behavior must be governed by complex, unpredictable sequences of external events, state machines offer the system architect an alternative to ordinary programmed logic. In some cases, a single state machine definition can encode a procedure that, under the conventional multitasking model, would best be accomplished by many cooperating tasks. A state machine definition, therefore, can sometimes provide a clearer, more compact encoding of a system's rules of operation than a collection of program modules can.

Although they are packaged as independent modules, **Cisr**, **Cstate**, and **Cevent** provide services that combine to provide solutions to a large class of realtime problems.

The **Cgraph** module provides device-independent graphics services. It achieves device independence by relying on user-supplied primitive routines to perform physical output to graphics devices. The user must supply a routine to draw a single point on the screen (the package includes plotting routines for the Color Graphics Adapter; the user must assemble the module). If the user's equipment can draw lines or display text, the user may supply primitive routines that call on the hardware to perform these functions; if these primitives are not supplied, **Cgraph** accomplishes the same operations by using the point-plotting routine.

Cgraph consists of about two dozen routines furnishing viewports, windowing, clipping, and text management. Although its use is not limited to realtime systems, it includes a framing facility that allows an application to manage many graphics displays concurrently. Using **Cgraph**, a program can create a graphics display, make a single subroutine call to save its graphics context (device, viewport and window dimensions and location, etc.), and go on to establish and fill other graphics displays. When the time comes to update the first window, its context can be restored with another single subroutine call.

Considered as a collection of software, C/Sharp is very valuable to the realtime system builder. Its concurrent processing support strikes a novel compromise between efficiency and breadth of multitasking support. It draws clear, well-placed boundaries between applications interfaces and environment-specific functions. C/Sharp's particular strength is portability. The same C/Sharp-based realtime system, given two sets of environment-specific support routines, could run equally well under a single user's process on a minicomputer time-sharing system or as a standalone system on a desktop computer.

As a product, C/Sharp earns lower marks because of its terse documentation and lack of example programs. All its routines are documented clearly in quick-reference form, but its documentation includes almost no design rationale or overview-level discussion. Users experienced in realtime systems will gain the insights necessary to combine C/Sharp's modules in cohesive system designs, but not without study and some experimentation.

An initial source license for C/Sharp is available from the Systems Guild in Cambridge, Massachusetts, for $495. Secondary source licenses for development on other CPUs are $150. Those incorporating C/Sharp object code into software for resale can enter a royalty agreement with the Systems Guild under which prices decline from $60 for each of the first ten copies to $40 for copies in excess of 100 units. The **Cgraph** package is available separately, for $49.95. Technical support is available by telephone to end users and system integrators.

—RF

C/Sharp Realtime Toolkit
Systems Guild, Inc.
P.O. Box 1085
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617/451-8479

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AMX source files, betray KADAK's hardware engineering background.

One criticism that could be leveled at AMX is more philosophical than substantive. Although AMX provides enough intertask synchronization facilities to meet all realtime system requirements, it does not provide functions equivalent to those of the classic semaphore-based **wait** and **post** primitives. The closest single mechanisms to semaphores are the AAWAIT/AAWAKE event synchronization routines, but these, unlike **wait** and **post**, have no memory. If an event-creating task calls AAWAKE before its event-consuming counterpart calls AAWAIT, the event is lost. The designer must make special provisions above the level of AMX to ensure that critical events are not lost in this way.

In addition to being ideal replacements for AAWAIT and AAWAKE, **wait** and **post** would provide a better, simpler foundation on which to build ad hoc synchronization schemes to meet unusual requirements than do AMX's complement of synchronization mechanisms. In any case, the omission is not a serious one, because traditional semaphores can be readily constructed under AMX by introducing a simple data structure and using AMX's AAWAIT, AAWAKE, and list management services.

Some potential users might perceive AMX's lack of dynamic configurability as a limitation. System configuration parameters, such as the number of tasks, timer procedures, buffer pools, and controlled resources, must be established at system generation time. This lack of dynamic configurability is not so much a product deficiency as it is a reflection of intended uses. AMX is not meant to support general purpose systems with highly dynamic requirements, such as UNIX-like time-sharing systems. It is best suited for building lean, dedicated realtime systems. It serves this purpose very well.

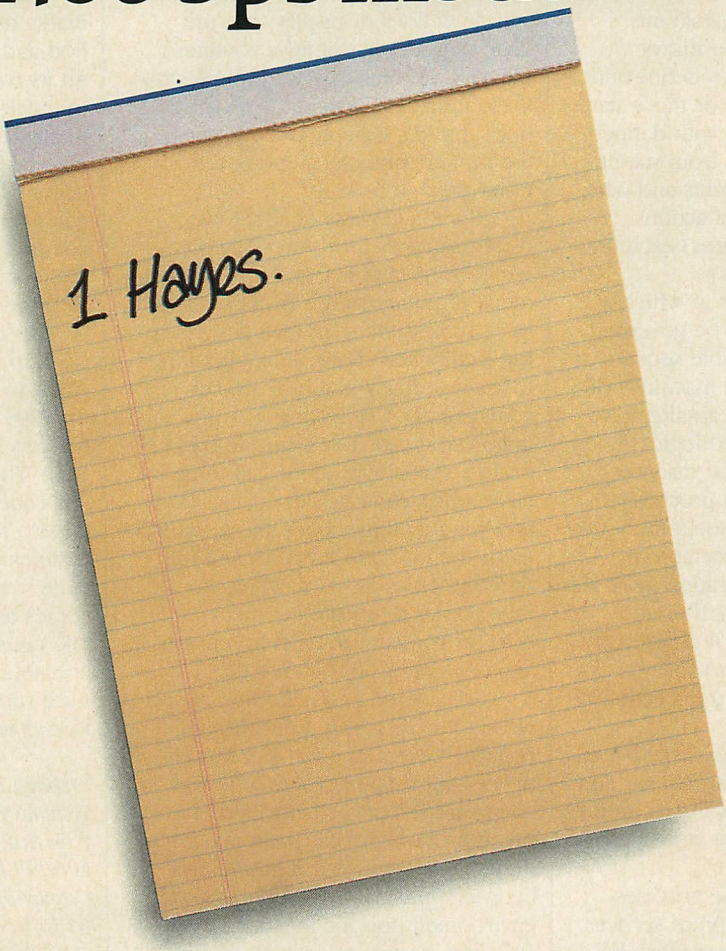
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Richard M. Foard is vice president of software development for ROADNET Systems.

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LISTING 1: AMX86.ASM

```
        TITLE   EXAMPLE AMX SYSTEM CONFIGURATION
;
;AN AMX86 CONFIGURATION MODULE DEFINING ALL
;TASKS, TIMERS, QUEUES, STACKS, ETC. REQUIRED
;BY AMX86 FOR PROPER OPERATION
;(BUILT BY THE KADAK AMX86 CONFIGURATION BUILDER)
;
;TASK ADDRESSES
;
        EXTRN   AMTMRT:FAR      ;TASK # 0 AMX86 TIMER TASK
        EXTRN   CONSIN:FAR      ;TASK # 1
        EXTRN   PRTOUT:FAR      ;TASK # 2
        EXTRN   SENSOR:FAR      ;TASK # 3
        EXTRN   APLTSK:FAR      ;TASK # 4
;
;RESTART PROCEDURE ADDRESSES
;
        EXTRN   AMTDRR:FAR      ;TIME/DATE RESTART PROCEDURE
;or      EXTRN   AMTDPC:FAR      ;TIME/DATE FOR IBM PC DOS
        EXTRN   AMRMRR:FAR      ;RESOURCE MANAGER
        EXTRN   AABIA:FAR               ;BUFFER MANAGER
        EXTRN   CONRST:FAR      ;USER RESTART PROCEDURES
        EXTRN   PRTRST:FAR
        EXTRN   CLKRST:FAR
        EXTRN   SENRST:FAR
        EXTRN   GLORST:FAR
;
;APPLICATION TIMER PROCEDURES
;
        EXTRN   AMTDTR:FAR      ;TIME/DATE TIMER PROCEDURE
        EXTRN   TMHRLY:FAR
        EXTRN   TMNOON:FAR
        EXTRN   TMSEC:FAR
;
;TIME/DATE USER SCHEDULER PROCEDURE
;
        EXTRN   TDSCHD:FAR
;
        PAGE
;THE AMX86 PARAMETER SEGMENT
AMXPAR  SEGMENT WORD 'CODE'
;
;ENTRY POINTS REQUIRED BY AMX86
;
        PUBLIC  AMTDT           ;TASK DEFINITION TABLE
        PUBLIC  AMRPL           ;RESTART PROCEDURE LIST
        PUBLIC  AMNUMQ          ;NUMBER OF QUEUE BLOCKS
        PUBLIC  AMCLKP          ;CLOCK PERIOD = # OF CLOCK
INTERRUPTS
        PUBLIC  AMTMRR          ;TIMER PROCEDURE LIST
        PUBLIC  AMISTP          ;AMX86 INTERRUPT STACK POINTER
;
;TIME/DATE PARAMETER TABLE ENTRY POINTS
;
        PUBLIC  AMTDFQ          ;TIMER FREQUENCY
        PUBLIC  AMTDTM          ;WORD DISPLACEMENT OF TIME/DATE
TIMER
        PUBLIC  AMTDRA          ;A(TIME/DATE RAM BLOCK)
        PUBLIC  AMTDSH          ;A(USER TIME/DATE SCHEDULER)
;
;TABLE OF APPLICATION TIMER DISPLACEMENTS ENTRY POINTS
;
        PUBLIC  TMTD            ;TIME/DATE TIMER
        PUBLIC  HOURLY
        PUBLIC  MIDDAY
        PUBLIC  PERSEC
;
;TABLE OF INTEGER TASK NUMBERS ENTRY POINTS
;
        PUBLIC  TNTMR           ;TASK # 0 AMX86 TIMER TASK
        PUBLIC  TNCONI          ;TASK # 1
        PUBLIC  TNPRTO          ;TASK # 2
        PUBLIC  TNSENS          ;TASK # 3
        PUBLIC  TNAPPL          ;TASK # 4
;
;RESOURCE MANAGER ENTRY POINTS
;
        PUBLIC  AMRDT           ;RESOURCE DEFINITION TABLE
```


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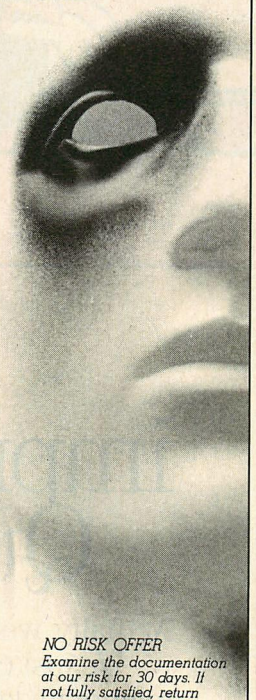
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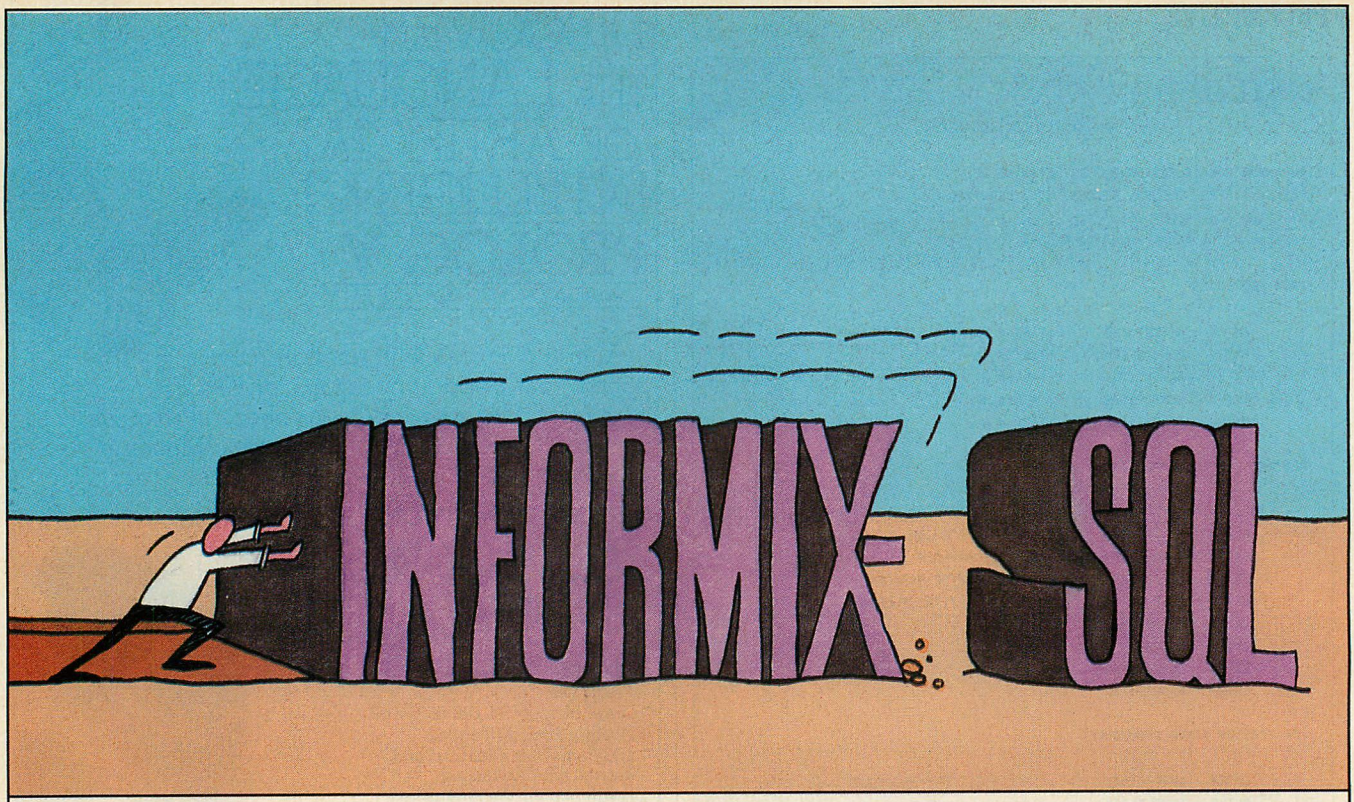
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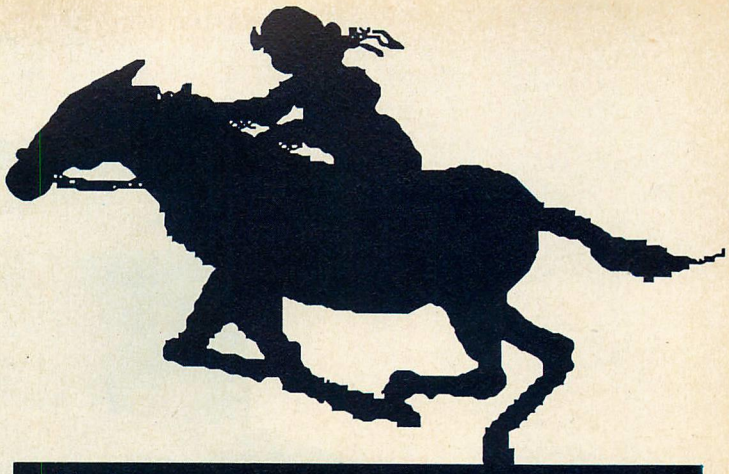
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```
        PUBLIC  PRINTR          ;RESOURCE NUMBER TABLE
        PUBLIC  MEMIO1
        PUBLIC  MEMIO2
        PUBLIC  ERRWIN
;
;BUFFER MANAGER ENTRY POINTS
;
        PUBLIC  AAPDT           ;POOL DESCRIPTION TABLE
;
        PAGE
;AMX86 TASK DEFINITION TABLE
AMTDT   LABEL   DWORD
;
;AMX86 TIMER TASK (#0) IS THE HIGHEST PRIORITY
;TASK # 0
        DD      AMTMRT          ;A(AMX86 TIMER TASK)
        DD      SPTMR           ;A(TIMER TASK STACK)
        DW      0               ;TASK ATTRIBUTES
        DW      0               ;LEVEL 0 (UNUSED)
        DW      0               ;LEVEL 1 (UNUSED)
        DW      0               ;LEVEL 2 (UNUSED)
        DW      0               ;LEVEL 3 (UNUSED)
;
;TASK # 1
        DD      CONSIN          ;START ADDRESS
        DD      SPCONI          ;STACK ADDRESS
        DW      0               ;TASK ATTRIBUTES
        DW      0               ;LEVEL 0 (UNUSED)
        DW      0               ;LEVEL 1 (UNUSED)
        DW      0               ;LEVEL 2 (UNUSED)
        DW      0               ;LEVEL 3 (UNUSED)
;
;TASK # 2
        DD      PRTOUT          ;START ADDRESS
        DD      SPPRTO          ;STACK ADDRESS
        DW      0               ;TASK ATTRIBUTES
        DW      8               ;LEVEL 0
        DW      8               ;LEVEL 1
        DW      8               ;LEVEL 2
        DW      8               ;LEVEL 3
;
;TASK # 3
        DD      SENSOR          ;START ADDRESS
        DD      SPSENS          ;STACK ADDRESS
        DW      0               ;TASK ATTRIBUTES
        DW      8               ;LEVEL 0
        DW      4               ;LEVEL 1
        DW      4               ;LEVEL 2
        DW      2               ;LEVEL 3
;
;TASK # 4
        DD      APLTSK          ;START ADDRESS
        DD      SPAPPL          ;STACK ADDRESS
        DW      0               ;TASK ATTRIBUTES
        DW      8               ;LEVEL 0
        DW      8               ;LEVEL 1
        DW      8               ;LEVEL 2
        DW      8               ;LEVEL 3
;
        DW      2 DUP(OFFFFH)   ;END OF TASKS
;
;TABLE OF INTEGER TASK NUMBERS
;
TNTMR   DW      0
TNCONI  DW      1
TNPRTO  DW      2
TNSENS  DW      3
TNAPPL  DW      4
;
;AMX86 RESTART PROCEDURE LIST IN ORDER OF EXECUTION
;
        EVEN
AMRPL   LABEL   DWORD
        DD      AMTDRR          ;TIME/DATE RESTART PROCEDURE
;or     DD      AMTDPC          ;TIME/DATE FOR IBM PC DOS
        DD      AMRMRR          ;RESOURCE MANAGER
        DD      AABIA           ;BUFFER MANAGER
        DD      CONRST          ;USER RESTART PROCEDURES
        DD      PRTRST
        DD      CLKRST
```

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	Scout	1Dir	Q-Dos	Window Dos	Ls Menu
Memory Resident	■				
Remove from memory without reboot	■				
Memory resident disk formatter	■				
Move to directories	■		■		
User selection of activation key	■				
Move files	■		■	■	
Mass file copy, delete	■				■
Search for files	■		■	■	■
Multiple file sorts	■		■	■	■
Display directories	■		■	■	■
Alter file attributes	■				
Change default directory	■		■	■	■
Display disk space	■				
View text files	■				
Set printer control codes	■				
Pop-up windows	■				
Display directory using file masks	■		■	■	■
Single-key commands	■		■	■	■
Create/remove directories	■		■	■	■
Tag, untag, and retag files	■		■	■	■
Rename files	■				
Rename directories	■		■	■	■
Cumulative file tag totals	■				
Edit or delete volume labels	■				
Print location of files found in search	■				
Print directory catalog	■				
Print listing of files in any directory	■				
Show CAPs and NUMLOCK status	■				
Display full day, date, time	■		■	■	■
Display DOS version	■				
Change sort type dynamically	■				

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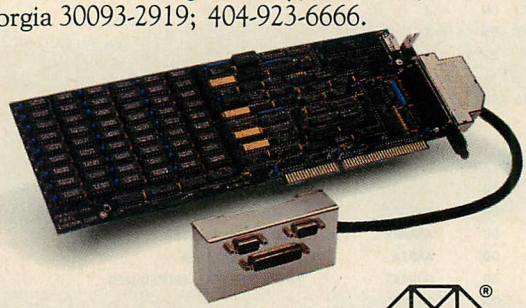
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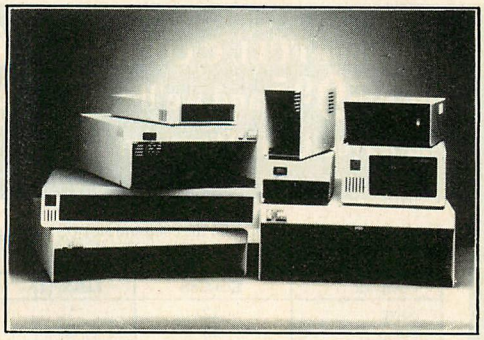
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```
        DD      SENRST
        DD      GLORST
;
        DW      2 DUP(OFFFFH)   ;END OF LIST
;
AMNUMQ  DW      300             ;# OF SYSTEM QUEUE PARAMETER BLOCKS
AMCLKP  DW      1               ;CLOCK PERIOD = # OF CLOCK INTERRUPTS
AMISTP  DD      AMISTK          ;AMX86 INTERRUPT STACK POINTER
;
;AMX86 APPLICATION TIMER PROCEDURE LIST
;
AMTMRR  LABEL   DWORD
        DD      AMTDTR          ;TIME/DATE TIMER PROCEDURE
        DD      TMHRLY
        DD      TMNOON
        DD      TMSEC
;
        DW      2 DUP(OFFFFH)   ;END OF LIST
;
;TABLE OF APPLICATION TIMER DISPLACEMENTS
;
TMTD    DW      0               ;TIME/DATE TIMER
HOURLY  DW      2
MIDDAY  DW      4
PERSEC  DW      6
;
;TIME/DATE USER PARAMETER TABLE
        EVEN
;
AMTDFQ  DW      18              ;TIMER FREQUENCY
AMTDTM  DW      0               ;WORD DISPLACEMENT OF TIME/DATE TIMER
AMTDRA  DD      TDRAM           ;A(TIME/DATE RAM BLOCK)
AMTDSH  DD      TDSCHD          ;A(USER TIME/DATE SCHEDULER)
;
;AMX86 RESOURCE DEFINITION TABLE
;
        EVEN
AMRDT   LABEL   WORD
        DW      4               ;NUMBER OF RESOURCES
        DW      5               ;QUEUEING DEPTH - RESOURCE # 1
        DW      3               ;QUEUEING DEPTH - RESOURCE # 2
        DW      3               ;QUEUEING DEPTH - RESOURCE # 3
        DW      8               ;QUEUEING DEPTH - RESOURCE # 4
;
;RESOURCE IDENTIFICATION NUMBER TABLE
;
PRINTR  DW      1
MEMIO1  DW      2
MEMIO2  DW      3
ERRWIN  DW      4
;
;BUFFER POOL DESCRIPTION TABLE
;
        EVEN
AAPDT   LABEL   WORD
        DW      2               ;NUMBER OF POOLS
        DD      RAM0            ;POINTER TO RAM AREA FOR POOL # 0
        DW      16              ;NUMBER OF BUFFERS IN POOL # 0
        DW      64              ;SIZE OF BUFFERS IN POOL # 0
        DD      RAM1            ;POINTER TO RAM AREA FOR POOL # 1
        DW      1024            ;NUMBER OF BUFFERS IN POOL # 1
        DW      4               ;SIZE OF BUFFERS IN POOL # 1
;
AMXPAR  ENDS                    ;END OF AMX86 PARAMETER SEGMENT
;
        PAGE
;THE AMX86 DATA SEGMENT
;
AMXDATA SEGMENT WORD 'DATA'
;
        PUBLIC  AMDATA          ;ENTRY POINT FOR AMX86 USE
;
AMDATA  LABEL   WORD
NT      EQU     5               ;# OF TASKS IN SYSTEM
QB      EQU     300             ;# OF QUEUE BLOCKS IN SYSTEM QUEUE
TQ      EQU     130             ;# OF WORDS REQUIRED FOR TASK QUEUES
NTM     EQU     4               ;# OF APPLICATION INTERVAL TIMERS
;
```

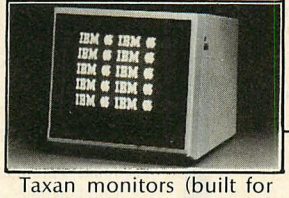

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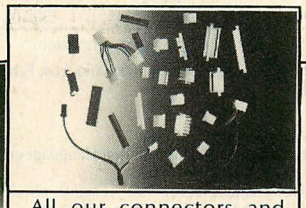
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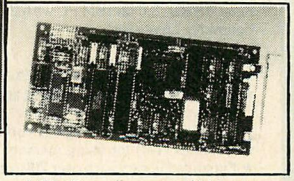
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```
        DW      32 DUP(?)       ;AMX86 PRIVATE STORAGE
        DW      (NT*32)+2 DUP(?) ;TASK CONTROL BLOCKS
        DW      (QB*9)+4 DUP(?) ;AMX86 SYSTEM QUEUE
        DW      TQ DUP(?)       ;TASK QUEUE STORAGE
        DW      NTM DUP(?)      ;TIMER LIST
;
;TIME/DATE RAM BLOCK
;
TDRAM   DB      9 DUP(?)
;
AMXDATA ENDS                    ;END OF AMX86 DATA SEGMENT
;
        PAGE
;AMX86 STACK SEGMENTS
;
AMXESTK SEGMENT WORD 'TSTACK'
        PUBLIC  AMESTK
        DW      512 DUP(?)
AMESTK  LABEL   WORD            ;AMX86 EXECUTIVE STACK
AMXESTK ENDS
;
AMXISTK SEGMENT WORD 'MSTACK'
        DW      768 DUP(?)
AMISTK  LABEL   WORD            ;AMX86 INTERRUPT STACK
AMXISTK ENDS
;
AMXTSTK SEGMENT WORD 'MSTACK'
        DW      128 DUP(?)
SPTMR   LABEL   WORD            ;AMX86 TIMER TASK STACK
AMXTSTK ENDS
;
;AMX86 LARGE TASK STACK SEGMENTS
;
CONITSTACK SEGMENT WORD 'TSTACK'
        DW      1024 DUP(?)
SPCONI  LABEL   WORD            ;STACK FOR TASK # 1
CONITSTACK ENDS
;
PRTOTSTACK SEGMENT WORD 'TSTACK'
        DW      512 DUP(?)
SPPRTO  LABEL   WORD            ;STACK FOR TASK # 2
PRTOTSTACK ENDS
;
SENSTSTACK SEGMENT WORD 'TSTACK'
        DW      1024 DUP(?)
SPSENS  LABEL   WORD            ;STACK FOR TASK # 3
SENSTSTACK ENDS
;
APPLTSTACK SEGMENT WORD 'TSTACK'
        DW      1024 DUP(?)
SPAPPL  LABEL   WORD            ;STACK FOR TASK # 4
APPLTSTACK ENDS
;
        PAGE
;AMX86 RESOURCE CONTROL TABLE
;
AMRMDATA SEGMENT WORD 'DATA'
;
        PUBLIC  AMRCT
;
        EVEN
AMRCT   DW      48 DUP(?)       ;ALLOCATE STORAGE
;
AMRMDATA ENDS
;
        PAGE
;BUFFER POOL STORAGE AREAS
;
AABMDATA SEGMENT WORD 'DATA'
;
RAM0    DB      1094 DUP(?)     ;RAM FOR POOL # 0
RAM1    DB      8198 DUP(?)     ;RAM FOR POOL # 1
;
AABMDATA ENDS
;
        END
```


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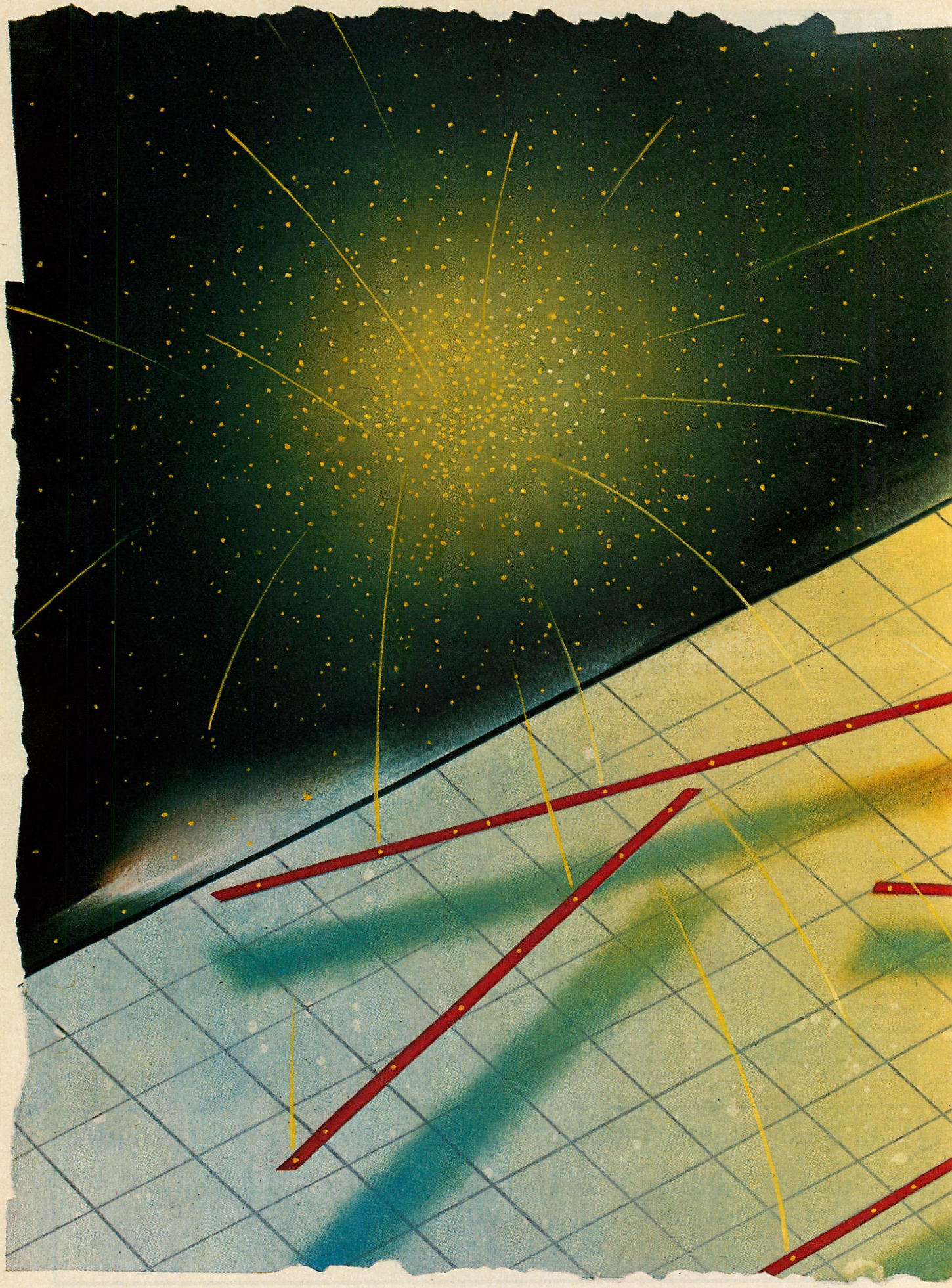
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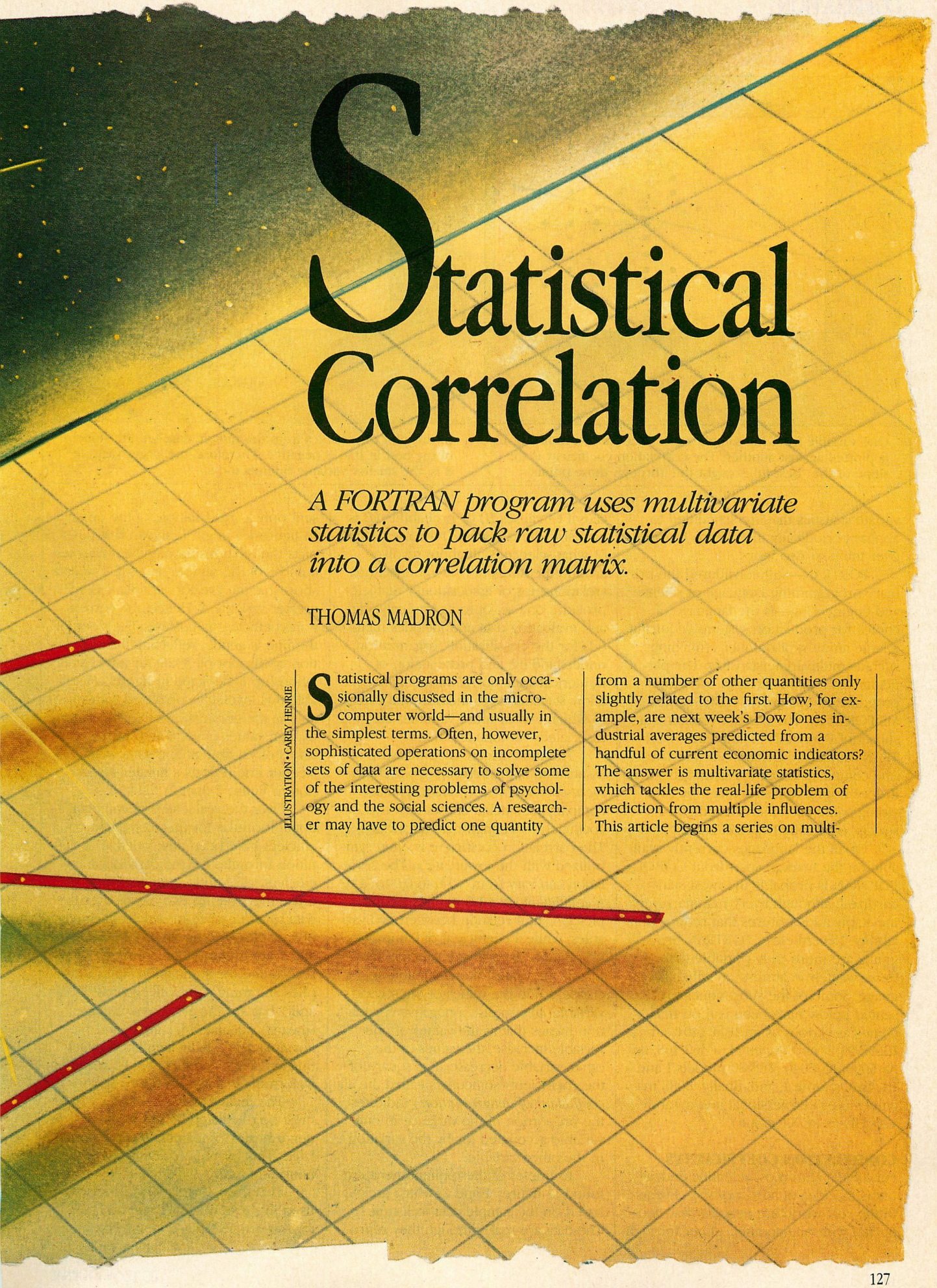
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Statistical Correlation

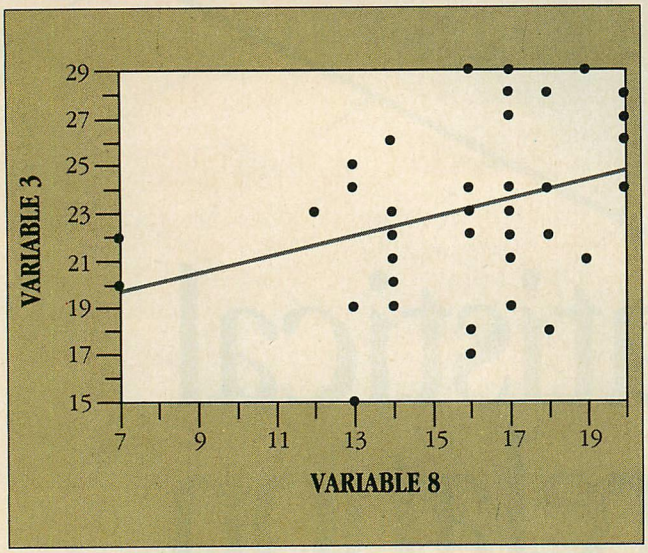
A FORTRAN program uses multivariate statistics to pack raw statistical data into a correlation matrix.

THOMAS MADRON

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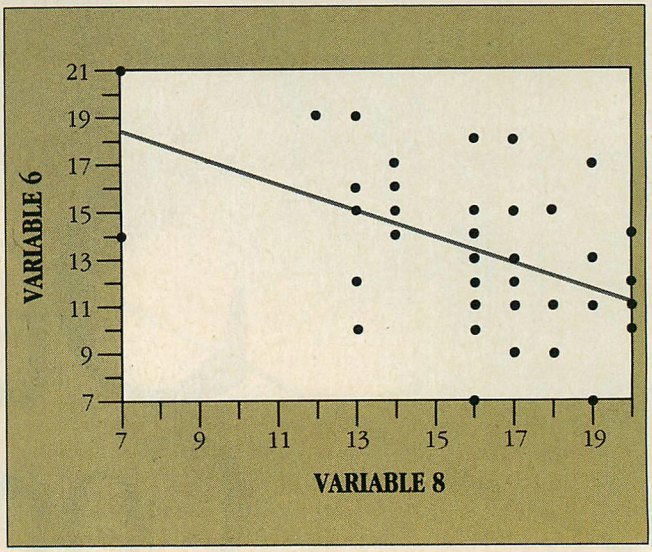
Statistical programs are only occasionally discussed in the microcomputer world—and usually in the simplest terms. Often, however, sophisticated operations on incomplete sets of data are necessary to solve some of the interesting problems of psychology and the social sciences. A researcher may have to predict one quantity from a number of other quantities only slightly related to the first. How, for example, are next week's Dow Jones industrial averages predicted from a handful of current economic indicators? The answer is multivariate statistics, which tackles the real-life problem of prediction from multiple influences. This article begins a series on multi-

FIGURE 1: *Positive Correlation Coefficient*



One variable from the sample input data (shown in listing 1) is plotted against another. The correlation coefficient is the slope of the "best fit" straight line through those points.

FIGURE 2: *Negative Correlation Coefficient*



In this plot of variables from the sample data set, the slope of the best fit line is negative. Therefore, the larger variable 8 is, the smaller variable 6 tends to be.

variate statistics that are scheduled to appear periodically in *PC Tech Journal* over the next two years.

FORTRAN—still considered the primary programming language of science and engineering—is the language of choice for production systems requiring a large amount of number crunching, such as multivariate statistics. The particular dialect of FORTRAN used for programs in this article is Microsoft's MS-FORTRAN. The current version is a subset of FORTRAN-77, the latest FORTRAN standard. FORTRAN-77 alleviates one complaint about the language—that it does not force a structure—by providing some useful structured constructs, especially IF/THEN/ELSE.

Of all the languages currently available on the market, apart from COBOL, FORTRAN is probably the most standardized, although every manufacturer inevitably adds features that reduce portability. Nevertheless, FORTRAN programs are more truly portable than those written in almost any other language. Some of the subroutines presented below have been run on machines as various as an IBM 1401, an IBM 360/40 and System/3, a 360/168, an AS/5000, AS/8040, TRS-80 models I and III, an Osborne I, and, finally, 8088 machines—a TI Professional and a Tandy 1200HD (a PC/XT clone).

CORRELATION COEFFICIENTS

Fundamental to most scientific endeavors is the idea of a *relationship*. Events in the real world are in some way connected with one another, either through causal (*A* causes *B*) or probability (*B* is probably the result of *A*) theories. Much of what science is all about revolves around measures of those connections (relationships or associations). Statistics provides one set of tools for analyzing and evaluating data and includes methods for the classification, organization, understanding, and presentation of numerical data. *Correlation coefficients* allow statisticians to measure the extent to which two or more variables are associated with one another.

The most widely used measure of association is the *Pearson product moment correlation coefficient*. The accompanying sidebar shows how this coefficient is defined mathematically. The correlation coefficient is often symbolized with the lowercase *r*. The correlation can vary from +1.0 to 0.0 to -1.0. A coefficient of ±1.0 implies a completely causal relation between two variables, while a coefficient of 0.0 implies no relation. A positive coefficient means that as the values of one variable increase, so do the values of the second variable. In contrast, a negative correlation means that as the values of one variable increase, the values of the other variable decrease. The square of the coefficient (sometimes called the *coefficient of determination*) indicates the proportion of the variance in one variable accounted for by the variation in the other variable.

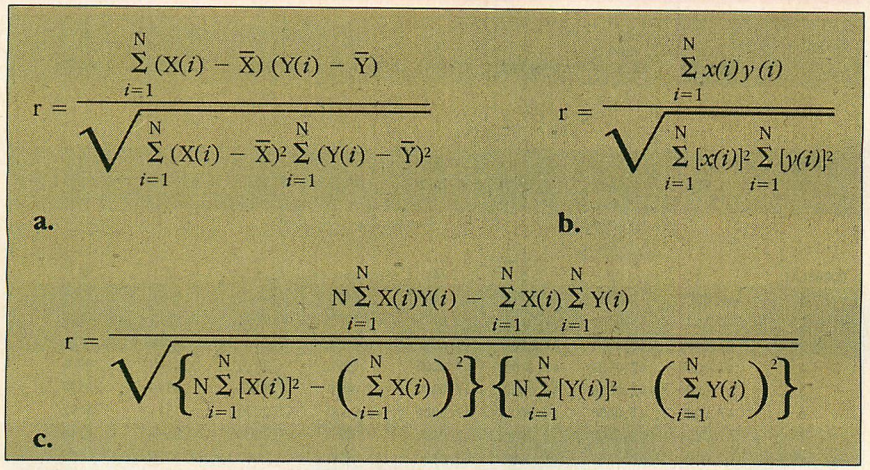
Examples of these phenomena are found in figures 1 and 2, which are based on the sample data in listing 1. The data are real, although they represent only a small sample of the original. In figure 1 a graph is shown that depicts the relationship between variables 8 and 3 of the sample data set. The data show that the greater variable 8 is, the greater variable A. Hence, the correlation coefficient is positive. The slope of the line is gentle, reflecting the correlation coefficient of .3328. An inverse relationship is depicted in figure 2. Variable 8 is inversely correlated with variable 6; the graph shows the association of high values of variable 6 with lower levels of variable 8. The somewhat steeper line reflects a greater association in figure 2 than in figure 1.

Over the years, several computational formulas for the correlation coefficient have been developed. The definition formulas for the correlation coefficient take too long to compute because they require two passes over the data to accumulate means for each pair of variables (see figure 3*a*) where *X* and *Y* are two variables from the same record and the summation sign (Σ) implies summing across all records. *X*-bar and *Y*-bar are the arithmetic averages (means) calculated for all *X*s and *Y*s. Formula *a* is usually simplified by letting $x=(X-\bar{X})$ and $y=(Y-\bar{Y})$, resulting in formula *b* shown in figure 3.

The means of the *X* and *Y* variables must be calculated before numerator or denominator of formula *b* can be calculated. This formula (*c*) is shown at the bottom of figure 3.

This third correlation formula is used in the FORTRAN program listed after this article. The program, composed

FIGURE 3: *Correlation Formulas*



$$r = \frac{\sum_{i=1}^{N} (X(i) - \bar{X})(Y(i) - \bar{Y})}{\sqrt{\sum_{i=1}^{N} (X(i) - \bar{X})^2 \sum_{i=1}^{N} (Y(i) - \bar{Y})^2}}$$

a.

$$r = \frac{\sum_{i=1}^{N} x(i)\,y(i)}{\sqrt{\sum_{i=1}^{N} [x(i)]^2 \sum_{i=1}^{N} [y(i)]^2}}$$

b.

$$r = \frac{N\sum_{i=1}^{N} X(i)Y(i) - \sum_{i=1}^{N} X(i) \sum_{i=1}^{N} Y(i)}{\sqrt{\left\{N\sum_{i=1}^{N} [X(i)]^2 - \left(\sum_{i=1}^{N} X(i)\right)^2\right\}\left\{N\sum_{i=1}^{N} [Y(i)]^2 - \left(\sum_{i=1}^{N} Y(i)\right)^2\right\}}}$$

c.

The Pearson product moment correlation coefficient is defined by formula *a*, which is often simplified to formula *b*. Although more complicated, formula *c* can be computed much more quickly than the other two formulas can.

of a main routine CORL.FOR (listing 2) and an I/O library STAT.FOR (listing 3), performs correlations on input data. Data are entered in matrix form with each column representing a separate variable and each row a specific sample or case. The program calculates a correlation coefficient *r* for all possible pairs of variables. The brains of the program exist in CORL.FOR; STAT.FOR contains I/O routines and features needed in a commercial package:

- Data are input from disk or keyboard.
- The user types in the format statement for data input so that record-oriented data that are entered in any format can be analyzed.
- Output can be to video, printer, or disk for later inclusion in other reports. The results are lists of means and standard deviations and the correlation matrix (see figure 4).
- The program outputs a standard matrix as data for subsequent programs. These data include the matrix of correlations in the upper right half of the output array, *N*s for each variable on the diagonal (see the "Sample Size" definition in the sidebar), and *N*s for each bivariate correlation in the lower diagonal matrix; a list of variable means; a list of variable standard deviations; the file name of the original data; and the format statement for accessing the original data.
- Ability to work on virtually any DOS-based machine.
- As presented, the program can handle a 100-by-100 correlation matrix.

The heart of the main program, CORL.FOR, is the subroutine CORR. It is general in form and can be used in any program that requires the calculation of correlation coefficients. CORR uses a computational formula that avoids the need for precalculated means. It uses a doubly dimensioned array, optimizing for speed rather than for conservation of memory. To make the correlation routine easy to use and to structure the program, routines are presented that display results in an appropriate manner. The main program calls each of the subroutines required to do significant processing. The block of comment statements describes parameters and shows several sources for the subroutines, indicative of the wealth of existing code. The subroutines are designed to be compiled and placed in the STAT.FOR library. This library will be used in subsequent articles in this series and will grow as other general purpose subroutines are developed.

Microsoft's LIB.EXE is used to create a new library. The subroutines to be placed in the library are compiled with Microsoft's FORTRAN compiler, creating an object module. This can be done one subroutine at a time, or all the subroutines can be placed together and compiled at one time. More object modules can easily be added to existing libraries. To add the new subroutine NEWPROG.OBJ to the library STAT.LIB, the following statements are entered:

```
C:\Compiler\Fortran: lib

   Microsoft Library Manager V2.00
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   Library name: stat
Operations: +newprog
List file: con
```

All the modules must be linked.

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An object module library is a good place to store frequently used subroutines, but it is often not enough. Source code is needed whenever the subroutines must be modified or maintained. Therefore, a source library should be structured in addition to the object module library. The easiest way to do so is to place all subroutines in subdirectories. When compiling a program, the compile-time option, $INCLUDE: <filespec>, can be used to include the appropriate routine with the main program. Notice, however, that some compilers other than MS-FORTRAN may use a slightly different syntax for the $INCLUDE statement. Appropriate use of object and source libraries can assist in maintaining a consistent library of subroutines.

CORL.FOR is designed to be easily customized. As an example, consider the customization required to deal with the common problem of missing data. Suppose a 10-question survey must be analyzed, but five percent of those surveyed did not answer question 3, and ten percent skipped over question 8. A correlation coefficient based on these two variables can have a somewhat different meaning than if all respondents had answered both questions. Moreover, the common number of respondents answering both questions 3 and 8 can be different than the number answering only 3 or 8.

In the example shown in figure 5, the total number of cases is 100. Five cases are missing from question 3 and ten from question 8. The ten cases from question 8 did not overlap (in this illustration) the five missing cases from question 3, however, so the combined number of cases answering both questions was 85 (the sum of the values in cells 1,1; 1,2; 2,1; and 2,2, which translates to 15+30+13+27=85). If data values are missing, the correlation matrix can be used, but the combined number of cases must be counted with good data. The cells of the lower triangular matrix can be used to store this value. A missing data option can be added to CORL.FOR without changing anything but the correlation routine itself.

Other customizations are not this easy. CORL.FOR is a linear analysis, finding a linear least-squares fit and preforming a linear transformation to normalize data around 0. Nonlinear fitting, on the other hand, is a very different approach (see "Nonlinear Least-Squares Fitting," Walter Schreiner, Michael Kramer, Simon Krischer, and Yedidyah Langsam, *PC Tech Journal*, May 1985, p. 170).

FIGURE 4: *Means, Standard Deviations, and Correlation Matrix*

MEANS	1	2	3	4	5	6	7	8
	33.5532	16.6809	23.2340	53.3830	20.3191	13.2766	12.5532	16.0638
STD.DEV.	1	2	3	4	5	6	7	8
	4.0728	4.4631	3.3909	8.1228	4.3128	3.1332	2.1616	2.9275
CORRELAT	1	2	3	4	5	6	7	8
1	47.0000	.4030	.6053	.4303	.6550	-.4972	.1997	.3718
2	47.0000	47.0000	.5349	.3778	.4032	-.5308	.0359	.1139
3	47.0000	47.0000	47.0000	.6147	.6947	-.4667	.2000	.3329
4	47.0000	47.0000	47.0000	47.0000	.5996	-.2015	-.0145	.0974
5	47.0000	47.0000	47.0000	47.0000	47.0000	-.5183	.2390	.4517
6	47.0000	47.0000	47.0000	47.0000	47.0000	47.0000	-.1514	-.5192
7	47.0000	47.0000	47.0000	47.0000	47.0000	47.0000	47.0000	.2365
8	47.0000	47.0000	47.0000	47.0000	47.0000	47.0000	47.0000	47.0000

The data in listing 1 produced this output. The correlation program prints averages and standard deviations for each of the eight variables, then prints a correlation matrix showing the correlation of each variable with every other variable.

FIGURE 5: *Sample Correlation Matrix*

		QUESTION 8			
		1	2	3	TOTALS
QUESTION 3	1	15	30	5	50
	2	13	27	5	45
	3	2	3	0	5
	TOTALS	30	60	10	100

Correlation techniques are applicable even if data are missing from a survey. In this example, ten people did not answer question 8, and five failed to answer question 3; therefore, the effective sample size is reduced by 15.

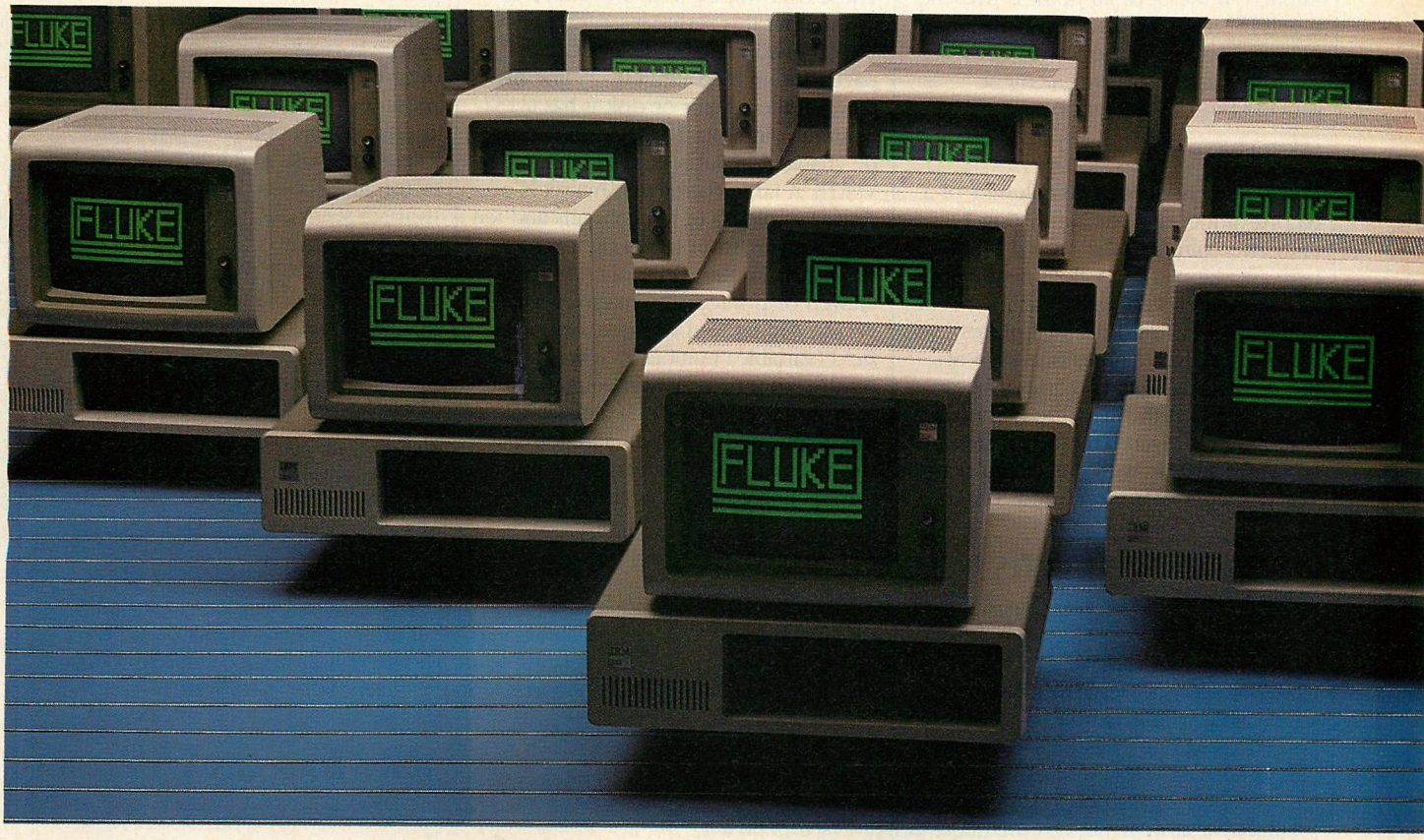
OPERATING CORL

The raw data required by the correlation program is a rectangular data matrix in which the columns represent variables (fields) and the rows are records (observations, cases, etc.). When the program is executed, the operator is asked for certain information: the source of the data (keyboard or disk), the destination of the output (video, printer, or disk), and whether the matrix is to be saved in standard form. If disk is chosen for any of these operations, the operator is asked to respond with the appropriate file names. If disk is chosen for data input, the operator also must be prepared to write a FORTRAN format statement.

The format statement is a list of codes in parentheses. Various format codes and editing characters define output structure. CORL requires two format codes: *X* and *F*. One set of codes is used for input and output. *X* instructs the FORTRAN compiler to skip a column of the record. In input, the compiler skips a column. In output, *X* causes a space to appear. A repeat count can precede a format character: 3*X* means skip three columns.

The *F* format character specifies real number format, indicating both the width of field and the number of decimal places to print. Use is *F<w>.<d>* where *<w>* is the total field width (including the decimal place) and *<d>*

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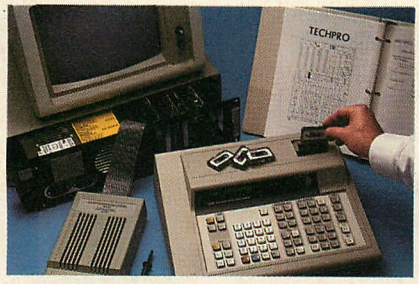


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is the number of decimal places. A repeat count is allowed, so 5*F*6.3 instructs the FORTRAN compiler to print or read five fields of numbers in the format xx.xxx. When an *F* format code is used for an input record, the decimal point can be "punched" in the data or implied. If the decimal point is present, it will override the number of decimal places specified by the format code.

A complete format statement provided to CORL might be:

```
(5X,7F4.0,F3.0)
```

This statement defines 36 columns of a record of the sample data (listing 1). First, five columns (the record ID number) are skipped (5X), then beginning in column 6, seven fields, each four columns long (with no decimal places), are defined. Next comes one field of three columns. This is required because the last field in this data file is shorter than the first seven. The format statement deals easily with this irregularity. The parentheses are required. The example format statement would be typed in when CORL requests a format; it would provide a correlation matrix of all the variables in the sample data.

The data consist of a random sample of 47 observations from a larger file—part of a study of social attitudes. These data will be used and added to throughout this series.

The video output from CORL is paged for an 80-column-by-25-line display; on the printer or disk it has a 132-column print line. These defaults can be changed in subroutines PRTS and VPRTS. A large correlation matrix is presented in blocks of ten columns and ten rows moving from left to right across the matrix so the entire matrix can be viewed or printed. The matrixes and vectors are labeled with the sequential field (variable) number as it was picked off the input record. Consequently, the user must keep track of which variables are being used. A helpful addition to the program might be variable names for labeling output.

The CORL program provides a useful system for calculating correlation matrixes. The correlations produced by the program can be saved in a standard matrix file so that they can be easily passed on to other programs.

The next article in this series will present a program that does partial and multiple correlations working from a simple correlation matrix that is produced by CORL. Future articles will present programs that do item and reliability analysis of tests and measurements, stepwise multiple regression, factor analysis, and other forms of multivariate statistics, all working from a correlation matrix as input. When the series is finished, the reader will have a running start on a large library of statistical and utility subroutines.

Thomas W. Madron, Ph.D., is the manager of computer services at North Texas State University and provides consulting services in many areas, including office automation and management and behavioral science.

GLOSSARY OF STATISTICAL TERMS

The definitions of some statistical terms reveal that the linear correlation performed by CORL.FOR (shown in listing 2) is quite a simple process.

Bivariate analysis. Describes a relation between only two variables. As an example, consider a magazine reader survey with several questions. Bivariate analysis answers questions such as "How well can we predict a reader's answer to question 2 given his response to question 1?"

Multivariate analysis. Studies the effect of many factors on a single event. Multivariate analysis handles real-life tasks such as predicting future stock market performance from a bevy of economic indicators.

Sample size. A sample is a selection of cases from a population. The sample size *N* is the number of cases or events. If the data come from a questionnaire with 1,000 respondents, *N* is 1,000. *N* rows exist in the input data matrix.

Mean. Also called arithmetic average, the mean is defined for a sequence of numbers *X*(1), *X*(2), . . . *X(N)*. It is denoted as *X*-bar and is defined as the following:

$$\bar{X} = \frac{\sum_{i=1}^{N} X(i)}{N}$$

Standard deviation. A measure of the degree of fluctuation of a sequence *X*(1), *X*(2), . . . *X(N)*, standard deviation is denoted with a sigma symbol and is defined as

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N} [X(i) - \bar{X}]^2}{N}}$$

Correlation coefficient. The correlation coefficient *r* shows how closely related a sequence *X*(1), *X*(2), . . . *X(N)* is to a sequence *Y*(1), *Y*(2), . . . *Y(N)*. Specifically, $|r|=1$ means *Y* is a linear function of *X*, and $|r|=0$ means *X* and *Y* have no linear relation at all. The definition of the Pearson product moment correlation coefficient is

$$r = \frac{\sum_{i=1}^{N} (X(i) - \bar{X})(Y(i) - \bar{Y})}{\sqrt{\sum_{i=1}^{N} (X(i) - \bar{X})^2 \sum_{i=1}^{N} (Y(i) - \bar{Y})^2}}$$

For a graphical interpretation of *r*, see figures 1 and 2.

Correlation matrix. Consider three sequences: *X*(1), *X*(2), . . . *X(N)*; *Y*(1), *Y*(2), . . . *Y(N)*; and *Z*(1), *Z*(2), . . . *Z(N)*. A 3-by-*N* data matrix such as the following

X(1)	Y(1)	Z(1)
X(2)	Y(2)	Z(2)
•	•	•
•	•	•
•	•	•
X(N)	Y(N)	Z(N)

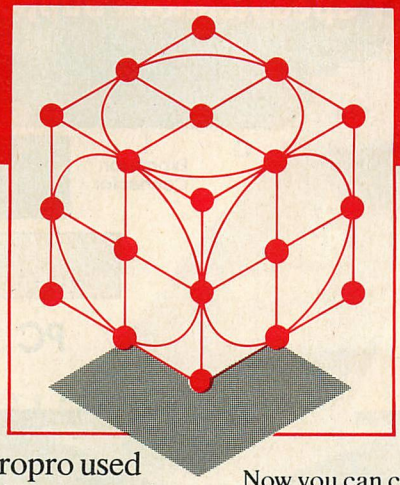
can be formed with *X*, *Y*, and *Z* as columns. The CORL.FOR program (see listing 2) will compute all possible bivariate correlation coefficients among the sequences and output them in a correlation matrix:

1.0	r(1,2)	r(1,3)
N	1.0	r(2,3)
N	N	1.0

r (1,1) is the correlation coefficient between *X* and *X* (1.0). *r* (1,2) is the correlation coefficient between *X* and *Y*.

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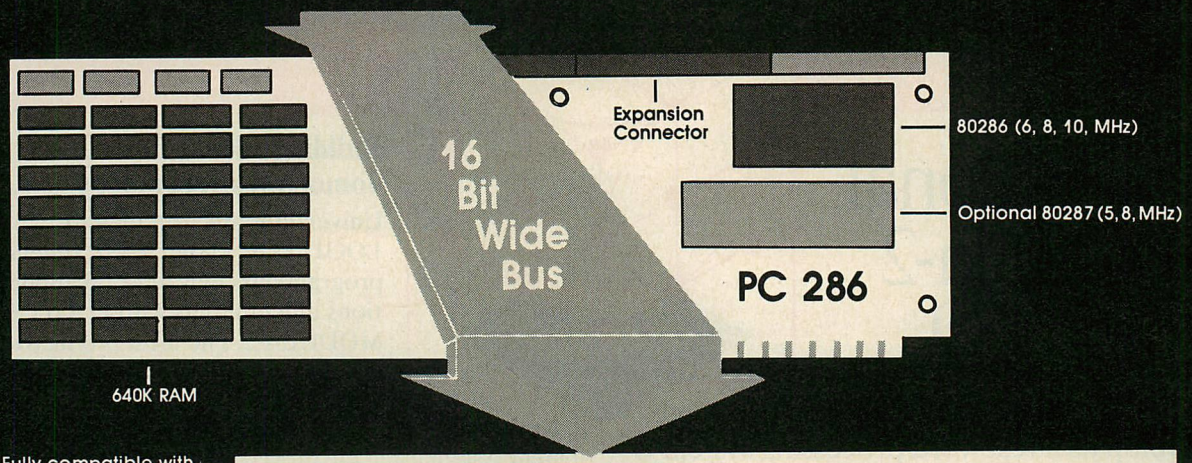
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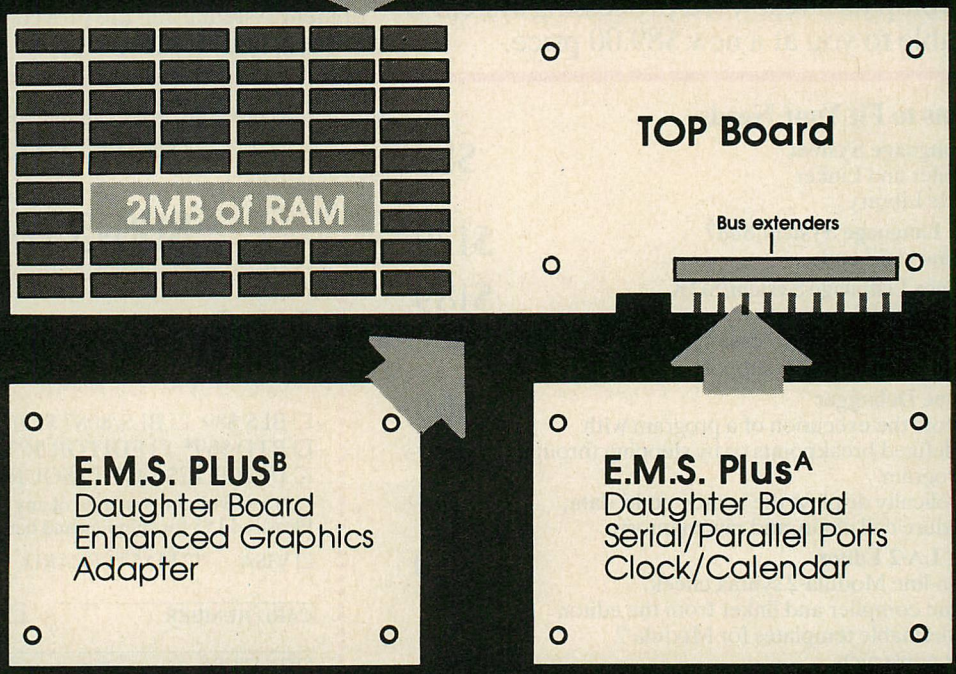
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LISTING 1: SAMPLE.DAT

```
  2 34. 12. 19. 56. 17. 16. 11. 13
  8 28. 15. 19. 47. 17. 13. 13. 17
 11 26. 14. 26. 60. 22. 10. 13. 20
 18 32. 15. 21. 49. 17. 17. 12. 19
 19 31. 21. 25. 60. 20. 12. 13. 13
 20 33. 14. 22. 48. 18. 14. 15. 16
 23 25.  8. 17. 32.  8. 15. 13. 16
 33 30. 13. 19. 38. 17. 17. 15. 14
 45 39. 22. 29. 60. 25. 11. 15. 16
 48 32. 25. 29. 58. 25.  7. 15. 16
 54 30. 14. 22. 62. 18. 15. 13. 14
 62 40. 25. 29. 60. 25. 11. 13. 19
 66 35. 19. 18. 46. 24.  9.  9. 18
 70 39. 20. 26. 63. 25. 10. 11. 20
 71 40. 13. 24. 47. 25. 11. 13. 20
 74 25. 10. 15. 48.  9. 19. 10. 13
 81 32. 12. 23. 54. 20. 19.  8. 12
 84 35. 16. 23. 53. 15. 15. 11. 14
 92 36. 21. 28. 69. 25. 11. 13. 20
 96 34. 19. 22. 52. 16. 15. 13. 18
108 30. 12. 24. 53. 24. 14. 15. 16
117 40. 21. 24. 56. 24. 10. 12. 16
121 31. 21. 24. 49. 19.  9.  8. 18
131 31. 17. 21. 42. 17. 13. 12. 19
133 38. 22. 28. 59. 25. 11. 15. 18
135 35. 14. 28. 52. 18. 15.  9. 17
137 36. 13. 26. 70. 23. 16. 15. 14
151 31. 18. 22. 47. 21. 18. 14. 16
155 37. 14. 24. 52. 21. 15. 15. 13
158 36. 13. 27. 61. 23. 14. 14. 20
160 26. 17. 22. 63. 19. 21.  6.  7
165 36. 17. 21. 51. 21.  7. 14. 19
168 39. 19. 26. 63. 24. 12. 12. 20
172 32. 20. 22. 56. 20. 12. 10. 17
173 38. 11. 23. 52. 20. 12. 12. 16
174 36. 21. 24. 61. 25. 15. 15. 17
175 33. 12. 18. 56. 23. 14. 15. 16
195 34. 19. 23. 57. 18. 12. 11. 16
199 34. 21. 23. 58. 24. 12. 12. 17
206 31.  7. 20. 41. 18. 14. 11. 14
221 32. 23. 20. 44. 10. 14. 13.  7
223 38. 23. 29. 47. 25.  9. 14. 17
233 36. 20. 25. 62. 25. 10. 11. 13
238 40. 17. 27. 63. 24. 11. 14. 17
240 30. 10. 21. 44. 21. 18. 15. 17
241 32. 14. 23. 44. 20. 13. 13. 16
253 29. 20. 21. 44. 15. 16. 14. 14
```

LISTING 2: CORL.FOR

```
      PROGRAM CORL
C .....................................................
C                Pearson Product Moment Correlation
C                   by Thomas Wm. Madron (1985)
C                        Denton, TX 76205
C PURPOSE:  To calculate a Matrix of Pearson Product Moment
C      Correlation coefficients, means, and standard
C      deviations.  Data may be entered from a disk file or
C      from the keyboard (and may be optionally saved if from
C      the keyboard).  Results may be sent to the video
C      display, the printer, or to a disk file and a standard
C      matrix file may be saved.
C REMARKS:  CORL requires all data to be present.  As written
C      it can handle 100 variables, although if the amount of
C      memory is a problem, dimension and specification
C      statements may be changed to reflect a smaller number.
C      The program will run faster if compiled to use an 8087
C      coprocessor.  In addition to providing normal output, a
C      primary purpose of the program is to generate a
C      standard matrix file for input to other programs.
C      NOTE:  When compiling the program and associated
C      subprograms, use the $STORAGE:2 and $D066 compiler
C      options.  The first changes the default for integer
C      lengths from 32 bits to 16 bits.  This reduces storage
C      requirements and speeds program execution.  The second
C      option changes the default method of handling DO loops
C      from the FORTRAN 77 conventions to FORTRAN 66 (FORTRAN
C      IV) conventions.  This was probably not necessary, but
C      many of the programs and subprograms in this series
C      were derived from FORTRAN 66 sources and the precaution
C      was thought the better part of valor.
C METHOD:  Any introductory statistics textbook describes the
C      Product Moment Correlation in some detail.
C SUBPROGRAMS REQUIRED:
C      SUBROUTINES:
C      CENTER (INPUT, OUTPUT, N)
C      CLS
C      CORR (N, NV, R, FMEAN, STD, T, FMT, INPDEV, IOUT, ND)
C      FILES (TITLE, IO, FILENM, STA)
C      HEADER
C      HELP (NCALL) [DUMMY IN THIS PROGRAM]
C      INPMNU (TITLE,IQ)
C      KEYBD (X, NV, NOBS, IOUT, IEND)
C      LOCATE (IROW, ICOL)
C      MOVE (FROM,LOC1,TO,LOC2,LENGTH)
C      OUTMNU (IOD, IDISK3, TITLE3)
C      PCDS (X, N, M, FH, IO, IDIAG, ND)
C      PRTS (X,N,M,NVAR,KH,ND,NSET,IDIAG)
C      SUBS (X, N, IO, ID)
C      VPRTS (TITLE,NVAR,X,NR,NC,FH,IDIAG,ND)
C      WAIT (NCALL)
C      WTMAT (R, FMEAN, STD, NV, DTFILE, FMT, TITLE,
C     1       IDISK4, IDIAG, N, LL, ND)
C      FUNCTIONS REQUIRED:
C      FUNCTION ICLS(IOUT)
C      FUNCTION INSTR (STRING, VALUE, LENVAL)
C      FUNCTION UPPER (CHARX)
C LOGICAL UNIT NUMBERS FOR FILES:  Six (6) Logical Unit
C      Numbers (LUNs) are reserved for standard file handling:
C      5 - Video Display Output, opened for 'CON'.
C      6 - Line Printer Output, opened for 'LPT1'.
C      1 - IDISK1:  Raw data input file.
C      2 - IDISK2:  Raw data output file.
C      3 - IDISK3:  Output file for results (print image).
C      4 - IDISK4:  Standard Matrix output file.
C .....................................................
C     SPECIFICATION STATEMENTS
      CHARACTER YM*1, YD*1, YES*1, TITLE*64, TITLE1*28,
     1 TITLE2*28, TITLE3*28, TITLE4*28, UPPER, FST*80, SEC*80,
     2 FILENM*14, DTFILE*14, INPUT*80, OUTPUT*80, FMT*80
      INTEGER*2 NVAR(100), I, J
      REAL*4 R(100,100), FMEAN(100), STD(100)
      COMMON /FILEX/ IDISK1,IDISK2,IDISK3,IDISK4
      COMMON /HEAD/ FST, SEC
C     MAXIMUM DIMENSION OF ROWS IN R:
      ND = 100
C     DISK FILES:
      IDISK1 = 1
      IDISK2 = 2
      IDISK3 = 3
      IDISK4 = 4
C     INITIALIZE VARIABLES
      INPDEV = 0
      IOUT = 0
      YES = 'Y'
      LL = 80
      IDIAG = 0
      ICRT = 5
      IPRT = 6
      NCALL = 0
C     TITLES FOR FILESPEC REQUESTS
      TITLE1 =  'Input Data Filespecs        '
      TITLE2 =  'Output Data Filespecs       '
      TITLE3 =  'Output Results Filespecs    '
      TITLE4 =  'Output Matrix Filespecs     '
C     HEADER TITLES
      FST = 'Pearson Product Moment Correlation Program\'
      SEC = 'by Thomas Wm. Madron (1985)\'
C     SETUP INPUT PARAMETERS
40    CALL HEADER
      WRITE (*,'('' Please Enter a Title for this Run:'')')
      READ (*,'(A)') TITLE
      WRITE (*,'('' How many variables will you need? ''\)')
      READ (*,'(I10)') NV
      IF (NV .GT. ND) THEN
          INPUT = '* * * Too Many Variables * * *\'
          CALL CENTER (INPUT, OUTPUT, LL)
          IROW = 10
          ICOL = 1
```

```
            CALL LOCATE (IROW, ICOL)
            WRITE (*,'(A)') OUTPUT
            CALL WAIT (NCALL)
            GO TO 40
        ENDIF
C       INITIALIZE NVAR(I)
        DO 50 I = 1,NV
            NVAR(I) = I
50      CONTINUE
        CALL INPMNU (TITLE, INPD)
        IF (INPD .EQ. 3) GO TO 100
        IF (INPD .EQ. 2) THEN
            CALL FILES (TITLE1, IDISK1, DTFILE, 'OLD')
            WRITE (*,
     1       '('' Please specify your data FORMAT: '')')
            READ (*,'(A)') FMT
        ELSEIF (INPD .EQ. 1) THEN
            WRITE (*,'('' Do You want to save the Data? ''\)')
            READ (*,'(A)') YD
            YD = UPPER(YD)
            IF (YD .EQ. YES) THEN
                CALL FILES (TITLE2, IDISK2, FILENM, 'NEW')
                IOUT = 2
            ENDIF
        ENDIF
C       SETUP OUTPUT PARAMETERS
        CALL OUTMNU (IOD, IDISK3, TITLE3)
        CALL HEADER
        WRITE (*,
     1 '('' Do you want to save the Matrix (y/n)? ''\)')
        READ (*,'(A)') YM
        YM = UPPER(YM)
        IF (YM .EQ. YES) THEN
            CALL FILES (TITLE4, IDISK4, FILENM, 'NEW')
        ENDIF
C       DO THE CORRELATIONS
        CALL CORR (N, NV, R, FMEAN, STD, T, FMT, INPD, IDISK1,
     *  IOUT, ND)
        IF (IOUT .GE. 1) THEN
            CLOSE (IDISK2, STATUS='KEEP')
        ENDIF
        IF (IOD .EQ. ICRT) THEN
C           PRINT MEANS, STD. DEVS., & CORRELATIONS TO VIDEO
            CALL VPRTS (TITLE,NVAR,FMEAN,NV,1,'MEAN',IDIAG,
     1          NCALL,ND)
            CALL VPRTS (TITLE,NVAR,STD,NV,1,'STD.',IDIAG,
     1          NCALL,ND)
            CALL VPRTS (TITLE,NVAR,R,NV,NV,'CORL',IDIAG,
     1          NCALL,ND)
        ELSE
C       PRINT MEANS, STANDARD DEVIATIONS, AND CORRELATIONS
C           IF IOD =
C               IPRT, THEN OUTPUT IS TO THE PRINTER
C               IDISK3, THEN OUTPUT IS TO DISK
            WRITE (IOD,'('' '',A)') TITLE
            CALL PRTS (FMEAN,NV,1,NVAR,'MEANS    ',ND,IOD,IDIAG)
            CALL PRTS (STD,NV,1,NVAR,'STD.DEV.',ND,IOD,IDIAG)
            II = ICLS (IOD)
            WRITE (IOD,'('' '',A)') TITLE
            CALL PRTS (R,NV,NV,NVAR,'CORRELAT',ND,IOD,IDIAG)
        ENDIF
C       SAVE THE MATRIX IN STANDARD DISK FORMAT, IF OPTED
        IF (YM .EQ. YES) THEN
            CALL WTMAT (R, FMEAN, STD, NV, DTFILE, FMT, TITLE,
     1      IDISK4, IDIAG, N, LL, ND)
        ENDIF
100     CALL CLS
        STOP 'FINI'
        END
        SUBROUTINE HELP (NCALL)
C       DUMMY SUBROUTINE NOT APPLICABLE TO CORL.FOR
        RETURN
        END
```

LISTING 3: STAT.FOR

```
        SUBROUTINE CENTER (INPUT, OUTPUT, N)
C ------------------------------------------------------
C       Center a Smaller String within A Larger String
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
```


What you see is what you get . . . and send!

```
Transfer Protocol: Modem7/CRC Packet Size:    128   Files:      1

| Block # | of  | Kbytes | %  | Time Remaining | Errors Consec | Errors File | Errors Total | Total Kbytes |
|---------|-----|--------|----|----------------|---------------|-------------|--------------|--------------|
|      31 | 522 |      3 |  5 |           5:06 |             0 |           0 |            0 |            3 |

Errors:
Status: Transfer in progress
      [MEX File Transfer]                          [CTL-C to abort]
Sending:   >ANYFILE.AQC
```



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The heart of EditCheck's contribution is a powerful C language program checker which provides strong type checking from within the editing environment. The checker does a thorough evaluation of your source code and detects common errors and questionable practices, including many that most C compilers will overlook.

The checker detects unused functions, and unused function arguments. At your option, unused external variables are also reported.

It also looks for functions called with a varying number of arguments.

In addition to the standard type checking performed by most compilers, EditCheck also looks for function arguments that do not agree in type with the arguments expected by the function. It looks for enumerated variables that are assigned values of a type other than that of the variable or that are used in operations not valid for enumerated types.

EditCheck complains about illegal type casts. At your option, it reports the assignment of longs to ints, of longs to chars, and of ints to chars.

The checker always reports when pointers refer to objects of different type.

If you set the environment option on, it checks for multiple definitions when all external symbol names are truncated to six characters. The EditCheck checker looks for names that would conflict if your Linker has a specific limit on the number of characters checked.

EditCheck's check facility tests for consistency of the external and global declarations of variables, functions and function arguments across multiple program modules. It also tests for consistency of the number of arguments between a function declaration and calls to the function.

At your option, the checker will also test for redefinition of an already defined symbol.

The checker runs interactively on part or all of a source program file, or group of program files. It opens a context window on the file where the error was detected and highlights the token which was being parsed when the error was detected. It also opens a message window with a descriptive error message, and presents a menu of options which you can take to correct the error.

These checker menu options on errors include: Show What's Legal, Delete, Modify, Edit, Backward Expand, Continue, Abort, and Forward Expand.

The checker allows you to provide a program module list for complete checking or checking of unchecked modules. You can also check the modules in this list in batch mode if you desire.

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Window-oriented Full Screen Editor

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The editor uses a file paging scheme which allows you to edit and check modules larger than your available RAM memory. Any ASCII file may be read by the editor. Files may be inserted or appended to the current window file.

The editor is both key-command driven and menu driven, or mixed usage. Key-commands are fully user reassignable.

Windows, Files, and More

The EditCheck environment is window-oriented. You may have as many windows open at the same time as you wish. Windows may overlap or be tilted, at your option. You may switch back and forth between windows, and move or copy information between them.

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Windows are also extensively used by the EditCheck system to build commands, display help, show a module list, display messages, show program context while checking, etc.

A group of environment commands are available to change the coloring of windows (with a color graphics adapter and display), set the way you are notified of errors, and redefine the meaning of keys on the keyboard.

Context Sensitive Help

Help is available to you in several ways. You may use a function key to get context sensitive help particular to where you are in the system. You may select the help index, and choose a topic of interest. You may also ask the help subsystem to search for a particular word of interest within the entire system. Display of current keybindings is also available.

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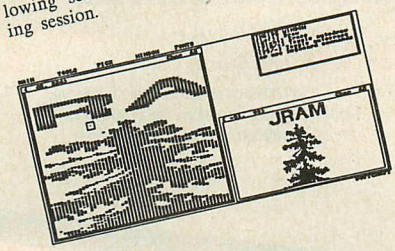
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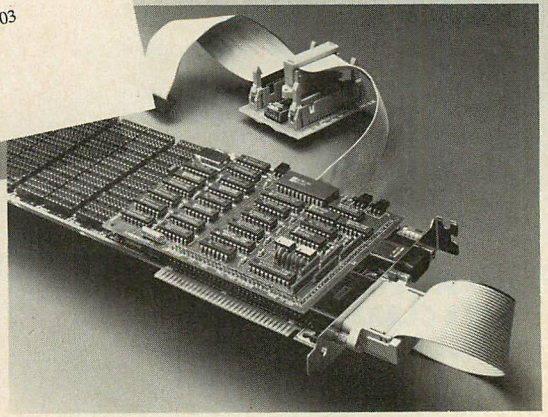
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CIRCLE NO. 197 ON READER SERVICE CARD

```
C PURPOSE:  To center 'INPUT' string in 'OUTPUT' string of 'N'
C       characters.
C USAGE:
C       CALL CENTER (INPUT, OUTPUT, N)
C DESCRIPTION OF PARAMETERS:
C       INPUT - Input  character  variable  of  length  80
C               containing  string  to be centered.  The actual
C               text of the string must be  terminated  with  a
C               backslash (\).
C       OUTPUT- Output string of length 80 printed or otherwise
C               used by the calling program returned with INPUT
C               centered on a line length of N characters.
C       N     - Total length < 80  in  which  INPUT  is  to  be
C               centered.
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:
C       INSTR
C       MOVE
C METHOD:  Not applicable.
C ..............................................................
      CHARACTER INPUT*80, BLANK*80, BLK(80), OUTPUT*80
      EQUIVALENCE (BLANK, BLK(1))
      DATA BLK/80*' '/
      OUTPUT = BLANK
      II = INSTR(INPUT, '\', 1) - 1
      JJ = (N-II)/2
      CALL MOVE (INPUT, 1, OUTPUT, JJ+1, II)
      RETURN
      END
      SUBROUTINE CLS
C ..............................................................
C                          Clear Screen
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To clear the MS-DOS display screen.
C USAGE:
C       CALL CLS
C DESCRIPTION OF PARAMETERS:  None.
C REMARKS:  On IBM  PC  systems,  or  close  compatibles,  the
C       ANSI.SYS device driver must be installed.  For machines
C       like  the TIPC ANSI screen handling is always in place.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  See  the  section  in  your  MS-DOS/PC-DOS  manual
C       describing  the  ANSI  escape  sequences and how to use
C       them.
C ..............................................................
      WRITE (*,10)
10    FORMAT (' 2J'\)
      RETURN
      END
      SUBROUTINE CORR (N, NV, R, FMEAN, STD, T, FMT,
     * INPDEV, IDISK1, IOUT, ND)
C ..............................................................
C              Pearson Product Moment Correlations
C SOURCE OR AUTHOR:  Thomas Wm. Madron.  Such subroutines  are
C       easily available in a wide variety of textbooks.
C PURPOSE:  Computes  means,  standard  deviations,  and  a
C       correlation  matrix from raw data from either a file or
C       keyboard.  If the data are from keyboard, they  may  be
C       optionally saved to a file for subsequent use.
C USAGE:
C       CALL CORR (N, NV, R, FMEAN, STD, T, FMT, INPDEV,
C      *  IDISK1, IOUT, ND)
C DESCRIPTION OF PARAMETERS:
C       N     - Number  of  Observations  calcualted  by
C               subroutine.
C       NV    - Number of Variables.
C       R     - Output correlation matrix.
C       FMEAN - Output vector of means.
C       STD   - Output vector of standard deviations.
C       FMT   - Character variable containing  variable  format
C               statement.
C       INPDEV- Data input device (>-2-Disk; 1-Keyboard).
C       IDISK1- Data input Logical Unit Number.
C       IOUT  - Data Output Flag (0-No ouput; 2-Disk  output).
C       ND    - Number of Rows Dimensioned  for  R  in  calling
C               program.
C REMARKS:  CORR cannot handle missing  data.   It  can  take
C       input from keyboard or disk, however.
C SUBPROGRAMS REQUIRED:
C       KEYBD - Keyboard Input Routine.
```


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CIRCLE NO. 121 ON READER SERVICE CARD

```
C      LOCATE - Place cursor at specified screen Row and
C               Column.
C METHOD:  Product Moment Correlations are computed.
C ------------------------------------------------------
       CHARACTER FMT*80
       REAL*4 R(ND,NV), FMEAN(NV), STD(NV), A, B, C
       N = 0
       IEND = 0
       DO 5 I = 1,NV
       FMEAN(I) = 0.0
       STD(I) = 0.0
       DO 5 J = 1,NV
       R(I,J) = 0.0
5      CONTINUE
       CALL HEADER
C      BEGIN DATA INPUT LOOP
10     GO TO (15, 20), INPDEV
C      INPUT FROM KEYBOARD
15          CALL KEYBD (STD, NV, N, IOUT, IEND)
            IF (IEND .EQ. 1) GO TO 50
            CALL WAIT (NCALL)
            GO TO 25
C      INPUT FROM DISK
20          READ (IDISK1,FMT,END=50) (STD(I),I=1,NV)
C           A LITTLE SPEED IN EXECUTION CAN BE GAINED BY
C           ELIMINATING THE FOLLOWING FIVE LINES AT THE
C           EXPENSE OF A LITTLE USER FRIENDLINESS.
            NX = N + 1
            NROW = 10
            NCOL = 28
            CALL LOCATE (NROW,NCOL)
            WRITE (*,'(''READING RECORD #'',I8)') NX
25     N = N + 1
       DO 40 I = 1,NV
            FMEAN(I) = FMEAN(I) + STD(I)
            DO 30 J = I,NV
                 R(I,J) = R(I,J) + STD(I) * STD(J)
30          CONTINUE
40     CONTINUE
       GO TO 10
```

```
C      END OF DATA INPUT LOOP
50     T = N
C      CALCULATE THE CORRELATIONS
       DO 70 I = 1,NV
            DO 65 J = I,NV
                 IF (I .EQ. J) GO TO 65
                 A = T*R(I,J) - (FMEAN(I)*FMEAN(J))
                 B = T*R(I,I) - FMEAN(I)**2
                 C = T*R(J,J) - FMEAN(J)**2
                 IF (B * C .EQ. 0.0) GO TO 65
                 R(I,J) = A / SQRT(B * C)
65          CONTINUE
70     CONTINUE
C      DO MEANS AND STANDARD DEVIATIONS
       DO 80 I = 1,NV
            FMEAN(I) = FMEAN(I) / T
            STD(I) = SQRT(R(I,I) / T - FMEAN(I)**2)
80     CONTINUE
C ------------------------------------------------------
C For consistency with a correlation program that accounts for
C missing data, "N" (sample size) is placed in both the
C diagonal of the Correlation Matrix and fills the lower
C diagonal matrix as well.  If you modify this program to
C allow for missing data, you will need the number of
C observations with all data present for each variable and the
C number of observations with all data present for each pair
C of variables.  Programs that calculate significance tests
C usually need an estimate of the number of observations.
C Subsequent programs use the LOWEST number of observations
C taken from the lower diagonal matrix as a conservative
C estimate since any significance tests based on a data matrix
C with missing data are suspect.
C ------------------------------------------------------
       DO 100 I = 1,NV
            DO 90 J = I,NV
                 R(J,I) = T
90          CONTINUE
100    CONTINUE
       RETURN
       END
```




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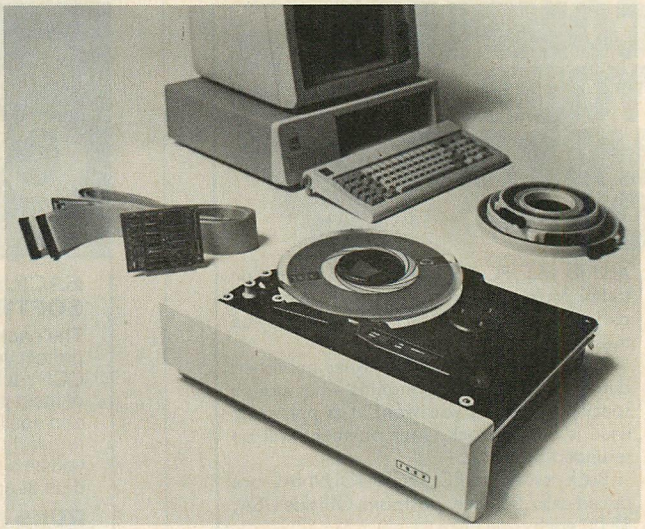
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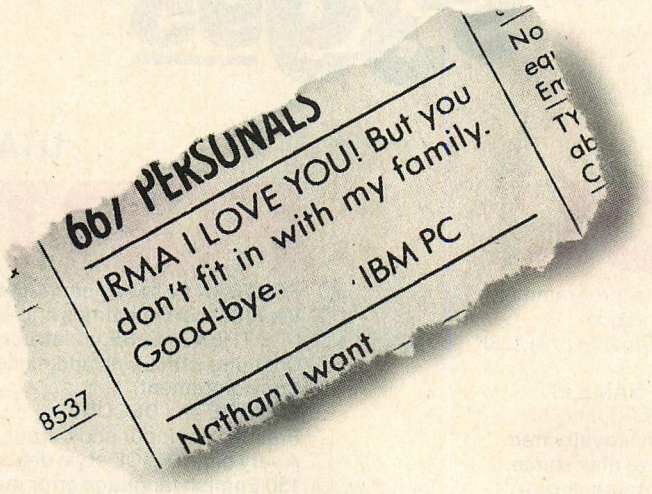
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PCTJ - 4/86

CIRCLE NO. 217 ON READER SERVICE CARD

```
      SUBROUTINE FILES (TITLE, IO, FILENM, STA)
C .....................................................
C                      Open Disk FILES
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To request filespecs from the  operator  and  open
C      appropriate  files.   The filespecs are returned to the
C      calling program for other uses.
C USAGE:
C      CALL FILES (TITLE, IO, FILENM, STA)
C DESCRIPTION OF PARAMETERS:
C      TITLE - 28 Character variable for prompt  to  operator.
C      IO    - FORTRAN logical unit number (LUN) to be opened.
C              Passed to FILES from the calling program.
C      FILENM- Character*14 variable containing filespecs.
C      STA   - STAtus for file ('NEW' or 'OLD').
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  Not applicable.
C .....................................................
      CHARACTER TITLE*28, FILENM*14, STA*3
      IOD = 1
      WRITE (*,'(1H ,A)') TITLE
C IF INPUT IS FROM DISK, THEN:
      WRITE (*,
     * '(1H ,''Please Enter Filespecs <d:filename.ext>: ''\)')
      READ (*,'(A)') FILENM
      IF (STA .EQ. 'NEW') THEN
           OPEN (IO, FILE=FILENM, STATUS='NEW',
     *          ACCESS='SEQUENTIAL')
      ELSEIF (STA .EQ. 'OLD') THEN
           OPEN (IO, FILE=FILENM, STATUS='OLD',
     *          ACCESS='SEQUENTIAL')
      ENDIF
      RETURN
      END
      SUBROUTINE HEADER
C .....................................................
C            Print a HEADER on the Video Display
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To print  a  HEADER  at  the  top  of  the  screen
C      consisting of three lines:
C      Line 1:  First title (TITLE1).
C      Line 2:  Second title (TITLE2).
C      Line 3:  Horizontal  divider  bar  entered  as  ASCII
C               character  205.   This  can  be  changed,  of
C               course,   to  anything  else.   One  possible
C               alternative might be an equals ('=') sign.
C REMARKS:  A named  COMMON  statement  (/HEAD/)  is  used  to
C      transmit  the two title lines to HEADER.FOR.  COMMON is
C      used, rather than a parameter list, so that the  titles
C      can be initialized once in the main program, and not in
C      every   subprogram   that   might   call   HEADER,   thus
C      conserving memory and programming effort.
C SUBPROGRAMS REQUIRED:
C      CLS
C      CENTER
C      LOCATE
C METHOD:  Not applicable.
C .....................................................
C     SPECIFICATIONS:
      CHARACTER*80 TITLE1, TITLE2, OUTPUT
      COMMON /HEAD/ TITLE1, TITLE2
C     Clear the Screen:
      LL = 80
      CALL CLS
C     Center and Print Program Name
      CALL CENTER (TITLE1, OUTPUT, LL)
      IROW=1
      ICOL=1
      CALL LOCATE (IROW, ICOL)
      WRITE (*,'(A78)') OUTPUT
C     Center and Print Author Name
      CALL CENTER (TITLE2, OUTPUT, LL)
      IROW=2
      ICOL=1
      CALL LOCATE (IROW, ICOL)
      WRITE (*,'(A78)') OUTPUT
C     Print a Horizontal Bar (ASCII CODE 205)
C     NOTE:  The Ms in FORMAT statement 10,  below,  is  the
C            character representation of the horizontal rule
C            --the ASCII character 205.  With  some editors
C            the  characters beyond decimal 127 can be added
C            by pressing the <ALT> key and at  the same time
C            entering  the  decimal equivalent of the letter
C            on the numeric keypad.   A possible alternative
C            character might be an equals (=) sign.
      WRITE (*,10)
10    FORMAT ('ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ',
     1        'ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ')
      RETURN
      END
      FUNCTION ICLS(IOUT)
C .....................................................
C                    Top of Forms Function
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To send an output device a  top-of-forms  command.
C USAGE:
C      II = ICLS(IOUT)
C DESCRIPTION OF PARAMETERS:
C      IOUT  - Output device: 1=video; 2=printer; >=3 =  disk.
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:
C      HEADER
C METHOD:  Not applicable.
C .....................................................
      ICRT = 5
      IPRT = 6
      IF (IOUT .EQ. IPRT) THEN
C          SEND TOP OF PAGE TO PRINTER
10         WRITE (IOUT,'(1H1)')
      ELSEIF (IOUT .EQ. IPRT) THEN
C          CLEAR VIDEO DISPLAY
30         CALL HEADER
      ELSE
C          SEND ONE BLANK LINE TO DISK FILE
50         WRITE (IOUT,60)
60         FORMAT (' ')
      ENDIF
      ICLS = IOUT
      RETURN
      END
      SUBROUTINE INPMNU (TITLE,IQ)
C .....................................................
C                     Data Input Menu
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:   To  allow  a  selection  for  raw  data   input,
C      initialize IQ, for return to the calling program.
C USAGE:
C      CALL INPMNU (TITLE, IQ)
C DESCRIPTION OF PARAMETERS:
C      TITLE - Character*64  variable  passed   from   calling
C              program.
C      IQ    - Pointer for input data type:
C              1 - from keyboard;
C              2 - from disk;
C              3 - return to DOS.
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:
C      HEADER
C METHOD:  Not applicable.
C .....................................................
      CHARACTER TITLE*64
1     CALL HEADER
      WRITE (*,'('' '',A)') TITLE
      WRITE (*,10)
10    FORMAT (' ARE THE DATA FROM:'//
     1 '      (1) KEYBOARD, OR'/
     2 '      (2) DISK, OR'/
     3 '      (3) RETURN TO DOS?'//
     4 ' WHICH DATA INPUT DEVICE? '\)
      READ (*,'(I5)') IQ
      IF (IQ .LT. 1 .OR. IQ .GT. 3) GO TO 1
      RETURN
      END
      FUNCTION INSTR (STRING, VALUE, LENVAL)
C .....................................................
C                    String Search Function
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To find  the  location  of  substring  'VALUE'  in
C      'STRING'.
C USAGE:
C      II = INSTR(STRING, VALUE, LENVAL)
```



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```
C DESCRIPTION OF PARAMETERS:
C      STRING- Character*80 variable is the string to be
C              searched.
C      VALUE - Character*80 variable is the source string.
C      LENVAL- The length of VALUE.
C REMARKS:  This is an attempt to provide in FORTRAN some of
C      the functionality of the INSTR$ function in BASIC.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  Not applicable.
C ------------------------------------------------------
      CHARACTER STRING*80, VALUE*80, ST*80, VL*80, STR, VALX
      DIMENSION STR(80), VALX(80)
      EQUIVALENCE (ST,STR(1)), (VL,VALX(1))
      ST = STRING
      VL = VALUE
      DO 100 I = 1,80
          IX = 0
          J = I
          DO 50 K = 1,LENVAL
              IF (STR(J) .NE. VALX(K)) THEN
                  GO TO 100
              ELSE
                  IX = IX + 1
                  J =  J + 1
              ENDIF
50        CONTINUE
          IF (IX .EQ. LENVAL) THEN
              K = I
              GO TO 150
          ENDIF
100   CONTINUE
      INSTR = 0
      RETURN
150   INSTR = K
      RETURN
      END
      SUBROUTINE KEYBD (X, NV, NOBS, IOUT, IEND)
C ------------------------------------------------------
C                  Data Input from Console
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To provide raw data input from the keyboard.
C USAGE:
C      CALL KEYBD (X, NV, NOBS, IOUT, IEND)
C DESCRIPTION OF PARAMETERS:
C      X(i)  - Input data array or record buffer.   Input
C              fields are placed in X(i).
C      NV    - Number of variables passed from calling
C              program.
C      NOBS  - Number of observations accumulated in calling
C              program and passed to KEYBD.
C      IOUT  - Flag for saving data to disk passed from
C              calling program.  Save if IOUT=2.
C      IEND  - Flag for end-of-data passed to the calling
C              program to terminate data input.
C REMARKS:  This is a relatively slow and unsophisticated data
C      entry routine for quick and dirty entry of small
C      datasets.  Large datasets should be entered with other
C      software.
C SUBPROGRAMS REQUIRED:
C      CLS SUBS
C METHOD:  Not applicable.
C ------------------------------------------------------
      CHARACTER ID*8
      CHARACTER DAT, DAT2*10, EN1, EN2, DOT, BLK, REC, REC2*8
      DIMENSION X(NV), REC(8), DAT(10)
      COMMON /FILEX/ IDISK1,IDISK2,IDISK3,IDISK4
      EQUIVALENCE (DAT(1),DAT2), (REC(1),REC2)
      DATA EN1/'E'/,EN2/'e'/,DOT/'.'/,BLK/' '/
      IEND = 0
      IOD = 1
      CALL CLS
      N = NOBS + 1
      WRITE (*,5)
5     FORMAT ('BEGIN ENTERING YOUR DATA -')
      DO 50 I = 1,NV
          DO 6 J = 1,10
              DAT(J) = BLK
6         CONTINUE
          WRITE (*,20) N, I
          READ (*,35) DAT
          DO 8 J = 1,10
              IF (DAT(J) .NE. EN1 .AND. DAT(J) .NE. EN2)
     *            GO TO 8
              IEND = 1
              GO TO 60
8         CONTINUE
          DO 9 J = 1,10
              IF (DAT(J) .EQ. DOT) GO TO 40
9         CONTINUE
          DO 11 J = 1,10
              IF (DAT(J) .NE. BLK) GO TO 11
              DAT(J) = DOT
              GO TO 40
11        CONTINUE
40        READ (DAT2,30) X(I)
50    CONTINUE
      WRITE (REC2,70) N
      READ (REC2,80) ID
      IF (IOUT .EQ. 2) CALL SUBS (X, NV, IDISK2, ID)
60    RETURN
C     FORMAT STATEMENTS
20    FORMAT (' OBSERVATION',I6,' VARIABLE',I4,': '\)
30    FORMAT (F10.0)
35    FORMAT (10A1)
70    FORMAT (I5,'  1')
80    FORMAT (A8)
      END
      SUBROUTINE LOCATE (IROW, ICOL)
C ------------------------------------------------------
C               Locate the Cursor on the Screen
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To locate the cursor at IROW and ICOL.
C USAGE:
C      CALL LOCATE (IROW, ICOL)
C DESCRIPTION OF PARAMETERS:
C      IROW  - Row to which cursor is to be moved passed from
C              calling program.
C      ICOL  - Column to which cursor is to be moved passed
C              from calling program.
C REMARKS:  Using ANSI screen control, this is an effort to
C      implement in FORTRAN a function similar to LOCATE in
C      MS-BASIC.  It requires that the ANSI.SYS device driver
C      be installed on IBM PC type machines.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  Uses ANSI screen control.
C ------------------------------------------------------
      CHARACTER AROW*2, ACOL*2, AFILE*2, BUF(2)*1, Z*1, B*1
      EQUIVALENCE (BUF(1), AFILE)
      Z='0'
      B=' '
      WRITE (AFILE,'(I2)') IROW
      IF (BUF(1) .EQ. B) BUF(1)=Z
      AROW=AFILE
      WRITE (AFILE,'(I2)') ICOL
      IF (BUF(1) .EQ. B) BUF(1)=Z
      ACOL=AFILE
      WRITE (*,10) AROW, ACOL
10    FORMAT (' ',A,';',A,'H'\)
      RETURN
      END
      SUBROUTINE MOVE (FROM,LOC1,TO,LOC2,LENGTH)
C ------------------------------------------------------
C                        Move Data
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To provide a means for moving a block of data from
C      one string to another.
C USAGE:
C      CALL MOVE (FROM, LOC1, TO, LOC2, LENGTH)
C DESCRIPTION OF PARAMETERS:
C      FROM  - Source string to be moved, <= 80 characters.
C      LOC1  - Starting location in FROM for block to be
C              moved.
C      TO    - Destination string for FROM data,  <=  80
C              characters but >= the amount of data to be
C              moved.
C      LOC2  - Starting location of the destination in TO.
C      LENGTH- Length of the block to be moved, passed from
C              the calling program.
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  Not applicable.
C ------------------------------------------------------
```

```
      CHARACTER FROM*80, TO*80, F2*80, T2*80, FROMX, TOX
      DIMENSION FROMX(80), TOX(80)
      EQUIVALENCE (F2,FROMX),(T2,TOX)
      F2 = FROM
      T2 = TO
      LOCA = LOC1 + LENGTH - 1
      LOCB = LOC2 - 1
      DO 100 I = LOC1,LOCA
           LOCB = LOCB + 1
           TOX(LOCB) = FROMX(I)
100   CONTINUE
      FROM = F2
      TO = T2
      RETURN
      END
      SUBROUTINE OUTMNU (IOD, IDISK3, TITLE3)
C ------------------------------------------------------
C                  Output Destination Menu
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To allow the user to specify the output device for
C      the normal 'printed' output:  video, printer, or  disk.
C USAGE:
C      CALL OUTMNU (IOD, IDISK3, TITLE3)
C DESCRIPTION OF PARAMETERS:
C      IOD   - Destination logical unit number  returned  from
C              subroutine.
C      IDISK3- Logical unit number for disk output if disk  is
C              destination  for  output.  If this is opted, IO
C              is set equal to IDISK3.
C      TITLE3- Title for filespec for disk output,  passed  to
C              subroutine FILES.
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:
C      HEADER
C      WAIT
C      FILES
C METHOD:  Not applicable.
C ------------------------------------------------------
      CHARACTER FILENM*14, TITLE3*28
      INTEGER*2 DRIVE
      ICRT = 5
      IPRT = 6
      NCALL = 0
5     CALL HEADER
      WRITE (*,10)
10    FORMAT (' DESTINATION OF OUTPUT:'//
     1 '      (1) VIDEO DISPLAY'/
     2 '      (2) PRINTER'/
     3 '      (3) DISK FILE'//
     4 ' WHICH OUTPUT DEVICE (ENTER APPROPRIATE NUMBER)? '\)
      READ (*,'(I5)') IOD
      GO TO (50, 30, 40), IOD
      IF (IOD .LT. 1 .OR. IOD .GT. 3) GO TO 5
C     OUTPUT TO PRINTER
30    CALL HEADER
      IROW = 4
      ICOL = (80-25)/2
           CALL LOCATE (IROW, ICOL)
      WRITE (*,'('!* * * READY PRINTER * * *!')')
      CALL WAIT (NCALL)
      OPEN (IPRT, FILE='LPT1')
      IOD = IPRT
      RETURN
C     OUTPUT TO DISK FILE
40    CALL FILES (TITLE3,IDISK3,FILENM,'NEW')
      IOD = IDISK3
      RETURN
C     OUTPUT TO VIDEO DISPLAY
50    OPEN (ICRT, FILE='CON')
      IOD = ICRT
      RETURN
      END
      SUBROUTINE PCDS (X, N, M, FH, IO, IDIAG, ND)
C ------------------------------------------------------
C                  Save Arrays to Disk
C SOURCE OR AUTHOR:  Modified from Donald J. Veldman,  FORTRAN
C      PROGRAMMING  FOR  THE  BEHAVIORAL  SCIENCES  (New York:
C      Holt, Rinehart and Winston, 1967),  pp.  135-37.    The
C      original was written for FORTRAN IV and was designed to
C      punch cards, hence the name 'PCDS' (Punch CarDS).
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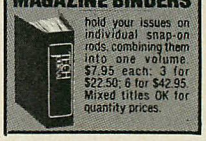
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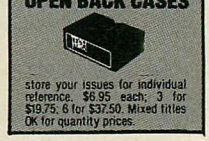
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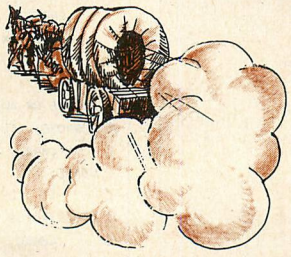
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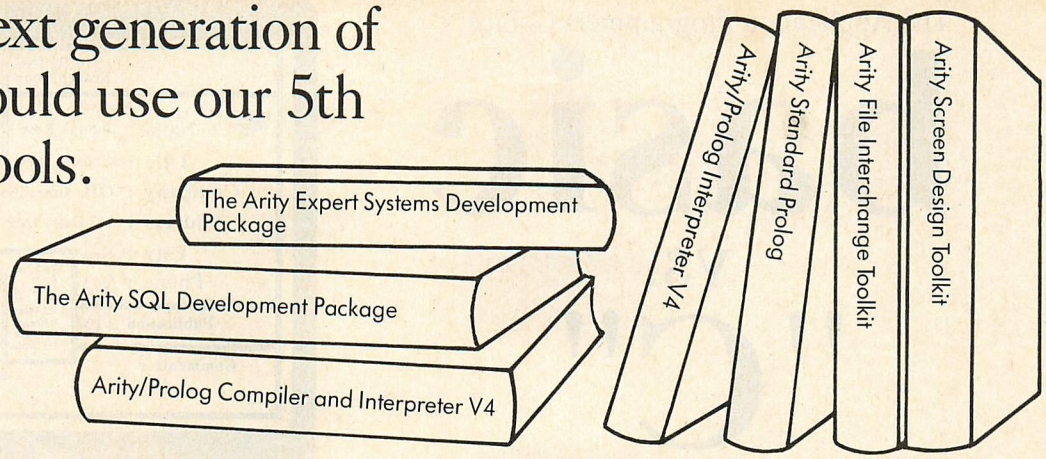
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```
C PURPOSE:  To  save  records  from  an  array  in  12-element
C       blocks.    A matrix is recorded by rows, beginning each
C       row with a new physical record.
C USAGE:
C       CALL PCDS (X, N, M, FH, IO, IDIAG, ND)
C DESCRIPTION OF PARAMETERS:
C       X      = NAME OF ARRAY TO BE OUTPUT.
C       N      = NUMBER OF ROWS IF X IS MATRIX, OR ELEMENTS IF A
C                VECTOR.
C       M      = NUMBER OF COLUMNS IF X IS MATRIX.  SET = 1  FOR
C                A VECTOR.
C       FH     = OUTPUT LABEL.  HOLLERITH BLOCK  (MAX  =  4)  IN
C                CALL STATEMENT.
C       IO     = OUTPUT LOGICAL UNIT NUMBER.
C       ND     = NUMBER OF ROWS DIMENSIONED  FOR  X  IN  CALLING
C                PROGRAM.
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  Not applicable.
C ------------------------------------------------------
      CHARACTER FH*4
      DIMENSION X(ND, M)
      L = 1
      IF (M .EQ. 1) THEN
          DO 10 I = 1,N,12
              J = MINO(I + 11, N)
              WRITE (IO,5) FH, M, L, (X(K,1), K = I,J)
5             FORMAT (A4,I2,I2,12F10.4)
              L = L + 1
10        CONTINUE
      ELSE
          DO 30 I = 1,N
              LL = 1
              DO 20 J = 1,M,12
                  K = MINO(J + 11, M)
                  WRITE (IO,5) FH, I, LL, (X(I,L), L = J,K)
                  LL = LL + 1
20            CONTINUE
30        CONTINUE
      ENDIF
      RETURN
      END
      SUBROUTINE PRTS (X,N,M,NVAR,KH,ND,NSET,IDIAG)
C ------------------------------------------------------
C                       Print a Matrix
C SOURCE OR AUTHOR:  Modified from Donald J. Veldman,  FORTRAN
C       PROGRAMMING  FOR  THE  BEHAVIORAL  SCIENCES  (New York:
C       Holt, Rinehart and Winston, 1967),  pp.  135-37.    The
C       original was written in FORTRAN IV.  PURPOSE:  To print
C       a matrix or vector in 10-column partitions.
C USAGE:
C       CALL PRTS (X,N,M,NVAR,KH,ND,NSET,IDIAG)
C DESCRIPTION OF PARAMETERS:
C       X(i)  - Array to be output.
C       N     - Number of rows  (or  elements)  of  X()  to  be
C               printed.
C       M     - Number of columns of X() to be printed (set = 1
C               if X() is a vector).
C       NVAR  - Vector of variable numbers.
C       KH    - Character*8 variable passed as a  constant  for
C               output heading.
C       ND    - Number of rows (or  elements)  dimensioned  for
C               X() in the calling program.
C       NSET  - Output Logical Unit Number.
C       IDIAG - Flag for diagonal matrix (0=no; 1=yes).
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  Not applicable.
C ------------------------------------------------------
      CHARACTER KH*8
      INTEGER*2 NVAR(1), I, J
      REAL*4 X(ND,1)
C     WRITE A VECTOR
      IF (M .EQ. 1) THEN
      WRITE (NSET,15)
      DO 10 I = 1,N,10
          J = MINO(I + 9,N)
          WRITE (NSET,5) KH, (NVAR(K), K = I,J)
          WRITE (NSET,15) (X(K,1), K = I,J)
10    CONTINUE
C     WRITE A DIAGONAL MATRIX
      ELSEIF (IDIAG .GT. 0) THEN
      WRITE (NSET,15)
      DO 110 I = 1,N,10
          J = MINO(I + 9,N)
          WRITE (NSET,5) KH, (NVAR(K), K = I,J)
          WRITE (NSET,15) (X(K,K), K = I,J)
110   CONTINUE
C     WRITE AN N X M MATRIX
      ELSEIF (M .GT. 1) THEN
      DO 25 K = 1,M,10
          WRITE (NSET,15)
          L = MINO(K + 9,M)
          WRITE (NSET,5) KH, (NVAR(J),J = K,L)
          DO 20 I = 1,N
              WRITE (NSET,30) NVAR(I), (X(I,J), J = K,L)
20        CONTINUE
25    CONTINUE
      ENDIF
      WRITE (NSET,'(/'' '')')
      RETURN
C     FORMAT STATEMENTS
   5  FORMAT (1H ,A8,10I11)
  15  FORMAT (1H , 10X, 10F11.4)
  30  FORMAT (1H , I6, 4X, 10F11.4)
      END
      SUBROUTINE SUBS (X, N, IO, ID)
C ------------------------------------------------------
C                 Write an Output Data Record
C SOURCE OR AUTHOR:  Modified from Donald J. Veldman,  FORTRAN
C       PROGRAMMING  FOR  THE  BEHAVIORAL  SCIENCES  (New York:
C       Holt, Rinehart and Winston, 1967),  pp.  135-37.    The
C       original was written for FORTRAN IV and was designed to
C       punch cards.
C PURPOSE:  To 'punch' one  subject's  score  vector  in  real
C       mode.
C USAGE:
C       CALL SUBS (X, N, IO, ID)
C DESCRIPTION OF PARAMETERS:
C       X(i)  - Array containing output data.
C       N     - Number of scores to be punched.
C       IO    - Output Logical Unit Number.
C       ID    - Character subject identification (Max=8).
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  Not applicable.
C ------------------------------------------------------
      CHARACTER ID*8
      REAL*4 X(1)
      M = IABS(N)
      L = 1
      DO 10 I = 1,M,7
          K = MINO(I + 6, M)
          WRITE (IO,5) ID, L, (X(J), J = I,K)
          L = L + 1
10    CONTINUE
      RETURN
5     FORMAT (A8, I2, 7F10.4)
      END
      FUNCTION UPPER (CHARX)
C ------------------------------------------------------
C               Lower to Upper Case Translation
C SOURCE OR AUTHOR:  Thomas Wm. Madron
C PURPOSE:  To convert an ASCII character from lower to  upper
C       case.
C USAGE:
C       II = UPPER(CHARX)
C DESCRIPTION OF PARAMETERS:
C       CHARX - Character*1 variable  used  to  pass  character
C               from the calling program.
C REMARKS:  If the function is compiled with the main program,
C       then UPPER must be declared as CHARACTER*1 only in  the
C       calling program.  If the function is added to a program
C       library,  then the CHARACTER declaration must be within
C       the function.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  Not applicable.
C ------------------------------------------------------
      INTEGER*2 IUPPER
C     CHARACTER CHARX
      CHARACTER CHARX, UPPER
      II = 0
```

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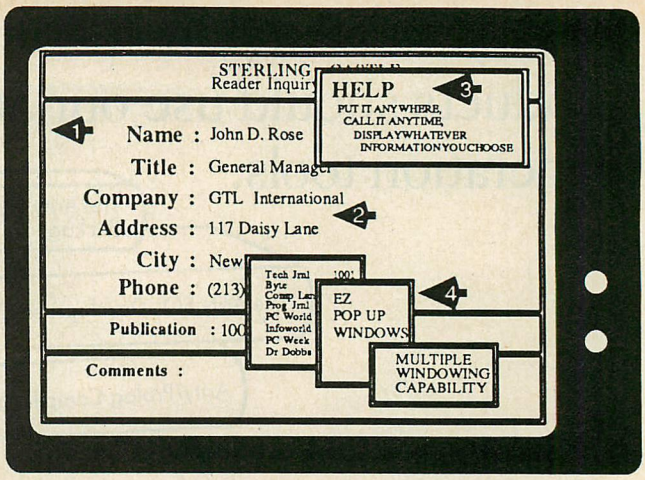
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The Application Programmers Choice:

basic VS. "C"



by Cary Harwin

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```
      JJ = ICHAR(CHARX)
      IF (95 .LT. JJ) II = -1
      IUPPER = JJ + (32 * II)
      UPPER = CHAR(IUPPER)
      RETURN
      END
      SUBROUTINE VPRTS (TITLE,NVAR,X,NR,NC,FH,IDIAG,NCALL,ND)
C ..................................................
C                    Display a Matrix
C SOURCE OR AUTHOR:  Modified from Donald J. Veldman,  FORTRAN
C      PROGRAMMING  FOR  THE  BEHAVIORAL  SCIENCES  (New York:
C      Holt, Rinehart and Winston, 1967),  pp.  135-37.   The
C      original was written in FORTRAN IV.
C PURPOSE:   To  print  a  matrix  or  vector  in  ten-column
C      partitions on an 80 column video display.
C USAGE:
C      CALL VPRTS (TITLE,NVAR,X,NR,NC,FH,IDIAG,NCALL,ND)
C DESCRIPTION OF PARAMETERS:
C      TITLE - Character*64 variable containing  a  title  for
C              the matrix.
C      NVAR  - Vector of variable labels.
C      X()   - Matrix to be printed.
C      NR    - Number of rows in the matrix.
C      NC    - Number of columns in the matrix (set = 1 if X()
C              is a vector).
C      FH    - Character*4 variable containing a name for  the
C              matrix for output.
C      IDIAG - Flag  for  printing  a  diagonal  matrix  (0=no;
C              1=yes).
C      NCALL - Counter for the number of times VPRTS is called
C              during an analysis.  Must be set  before  entry
C              to the subroutine.
C      ND    - Number of rows dimensioned in X().
C REMARKS:  None.
C SUBPROGRAMS REQUIRED:  None.
C METHOD:  Not applicable.
C ..................................................
      CHARACTER TITLE*64, FH*4
      INTEGER*2 NVAR(NR), I, J, M, IA, JA
      REAL*4 X(ND,NC)
C     PRINT AN N X M MATRIX
      IF (NC .GT. 1) THEN
      DO 100 I=1,NR,10
      IA = I+9
      IF (IA-NR) 15,10,10
10    IA = NR
15        DO 75 J=1,NC,10
              JA = J+9
              IF (JA-NC) 25,20,20
20            JA = NC
25            CALL HEADER
              WRITE (*,'('' '',A)') TITLE
              WRITE (*,50) FH, (NVAR(M),M=J,JA)
              DO 70 L=I,IA
                   WRITE (*,65) NVAR(L),(X(L,M),M=J,JA)
70            CONTINUE
              CALL WAIT (NCALL)
              IF (NCALL .GE. 1) GO TO 15
75         CONTINUE
100   CONTINUE
C     RETURN
C     PRINT A VECTOR
      ELSEIF (NC .EQ. 1) THEN
110   CALL HEADER
      WRITE (*,'('' '',A)') TITLE
      DO 130 I=1,NR,10
           J = MINO(I + 9, NR)
           WRITE (*,115) FH, (NVAR(K), K = I,J)
           WRITE (*,120) (X(K,1), K=I,J)
130   CONTINUE
      CALL WAIT (NCALL)
      IF (NCALL .GE. 1) GO TO 110
C     RETURN
C     PRINT A DIAGONAL MATRIX
      ELSEIF (IDIAG .GT. 0) THEN
210   CALL HEADER
      WRITE (*,'(A)') TITLE
      DO 230 I = 1,NR,10
           J = MINO(I + 9, NR)
           WRITE (*,115) FH, (NVAR(K), K=I,J)
           WRITE (*,120) (X(K,K), K=I,J)
230   CONTINUE
      CALL WAIT (NCALL)
      IF (NCALL .GE. 1) GO TO 210
      ENDIF
      RETURN
C     FORMAT STATEMENTS
50    FORMAT (1H ,A4,10I7)
65    FORMAT (1H ,I4,10F7.3)
115   FORMAT (1H ,A4,10I7)
120   FORMAT (1H ,4X,10F7.3)
      END
      SUBROUTINE WAIT (NCALL)
C ..................................................
C                    Wait for Response
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To pause for  operator  intervention  to  continue
C      execution of a program.
C USAGE: CALL WAIT (NCALL)
C DESCRIPTION OF PARAMETERS:
C      NCALL - Counter for the number of times VPRTS is called
C              to determine the help file to call.
C REMARKS:  If no help subroutines are used, a dummy help sub-
C      routine should accompany the main program.
C SUBPROGRAMS REQUIRED:
C      LOCATE (nrow, ncol)
C      INSTR (string, srchchar, len) [function]
C      UPPER (char) [function]
C      HELP (ncall)
C METHOD:  Uses ANSI screen control, see  your  MS-DOS  manual
C      for further information.
C ..................................................
      CHARACTER A, HELPX, UPPER, INPUT*80, OUTPUT*80
C     CHARACTER A, HELPX, INPUT*80, OUTPUT*80
      HELPX = 'H'
      IROW = 25
      LL = 80
      IF (NCALL .GT. 0) THEN
           INPUT =
     1       '<<Press (ENTER) to Continue or (H) for Help>>\'
           CALL CENTER (INPUT, OUTPUT, LL)
           ICOL = 1
           CALL LOCATE (IROW,ICOL)
           WRITE (*, '(A78\)') OUTPUT
           READ (*, '(A1)') A
           A = UPPER(A)
           IF (A .EQ. HELPX) THEN
                CALL HELP (NCALL)
           ELSE
                NCALL = 0
           ENDIF
      ELSE
           INPUT = '<<Press (ENTER) to Continue>>\'
           CALL CENTER (INPUT, OUTPUT, LL)
           ICOL = 1
           CALL LOCATE (IROW,ICOL)
           WRITE (*, '(A78\)') OUTPUT
           READ (*,'(A1)') A
      ENDIF
      RETURN
      END
      SUBROUTINE WTMAT (R, FMEAN, STD, NV, DTFILE, FMT,
     1 TITLE, IDISK4, IDIAG, N, LL, ND)
C ..................................................
C              Write a Standard Matrix to Disk
C SOURCE OR AUTHOR:  Thomas Wm. Madron.
C PURPOSE:  To save a standard matrix to disk.
C USAGE: CALL WTMAT (R, FMEAN, STD, NV, DTFILE, FMT, TITLE,
C     1 IDISK4, IDIAG, N, LL, ND)
C DESCRIPTION OF PARAMETERS:
C      R -       Doubly  Subscripted  array  containing  a
C                correlation or similar matrix.
C      FMEAN -   Singly  subscripted  array of means for  each
C                variable.
C      STD -     Singly  subscripted  array  of  standard
C                deviations for each variable.
C      NV -      Number of Variables.
C      DTFILE -  CHARACTER*14  character  variable  containing
C                the name of a raw data input file.
C      FMT -     CHARACTER*80  character variable containing a
C                standard format statement describing the  raw
C                data file.
```

```
C     TITLE -   CHARACTER*64 character variable containing a
C               title or label for the file.
C     IDISK4 -  Logical Unit Number (LUN) for output matrix
C               file.
C     IDIAG -   Flag for array type for use of Subroutine
C               SUBS.
C     N -       Number of observations represented by the
C               summary statistics (means, standard
C               deviations, and correlations).
C     LL -      Line Length for the video display--usually
C               80.
C     ND -      Number of row dimensions for the doubly
C               subscripted variable.
C REMARKS:
C     THE STANDARD MATRIX FILE:  The standard matrix file
C     is an ASCII file with a well defined format, produced
C     in part with SUBROUTINE PCDS.  It consists of six
C     record types:
C     1.  Header Record containing the number of variables
C         and title (not to exceed 64 characters) for the
C         matrix in the following format: (I5, A64)
C     2.  Record(s) containing a vector of means, one for
C         each variable.  The second field is a row number,
C         the third is a physical record number within the
C         logical record, followed by up to 12 floating
C         point numbers per physical record.  For a vector
C         the row number is always one (1).  For a
C         correlation matrix the number of rows will equal
C         the number of variables in the matrix.  The first
C         four columns contain 'MEAN': (A4,I2,I2,12F10.4)
C     3.  Record(s) containing a vector of standard
C         deviations for each variable.  The format is
C         identical to (2), above.
C     4.  Records containing a N x M correlation matrix,
C         including the correlation coefficients above the
C         diagonal, the number of observations for each
C         variable on the diagonal, and the number of obser-
C         vations present for each pair of variables on
C         which each corresponding correlation was based.
C         The format is identical to (2), above.
C     5.  File specifications (d:filename.ext) for the
C         original dataset not to exceed 14 characters.
C         This is used if subsequent programs require access
C         to the original data for residuals or other
C         predicted scores.
C     6.  Format statement for the raw data as read by CORL.
C         This is also used if subsequent programs require
C         access to the original data.
C SUBPROGRAMS REQUIRED:
C     CENTER (INPUT, OUTPUT, N)
C     HEADER
C     LOCATE (IROW, ICOL)
C     PCDS (X, N, M, FH, IO, IDIAG, ND)
C        NOTE:  IDISK4 must be opened prior to entry.
C METHOD:  Not Applicable.
C ..................................................
C     SPECIFICATION STATEMENTS
      CHARACTER DTFILE*14, FMT*80, TITLE*64, INPUT*80,
     1 OUTPUT*80
      REAL*4 R(ND,NV), FMEAN(NV), STD(NV)
      INTEGER*2 I, J
C     PREPARE TO WRITE THE STANDARD MATRIX
          CALL HEADER
          INPUT =
     1      '* * * Writing the Matrix, Please Wait * * *\'
          CALL CENTER (INPUT, OUTPUT, LL)
          NROW = 10
          NCOL = 1
          CALL LOCATE (NROW, NCOL)
          WRITE (*,'(A\)') OUTPUT
C     WRITE STANDARD MATRIX
          WRITE (IDISK4,'(I5,A)') NV, TITLE
          CALL PCDS (FMEAN,NV,1,'MEAN',IDISK4,IDIAG,ND)
          CALL PCDS (STD,NV,1,'STDV',IDISK4,IDIAG,ND)
          CALL PCDS (R,NV,NV,'CORL',IDISK4,IDIAG,ND)
          WRITE (IDISK4,'(A)') DTFILE
          WRITE (IDISK4,'(A)') FMT
          CLOSE (IDISK4, STATUS='KEEP')
      RETURN
      END
```

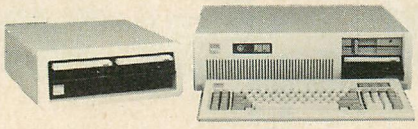

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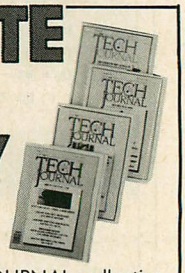
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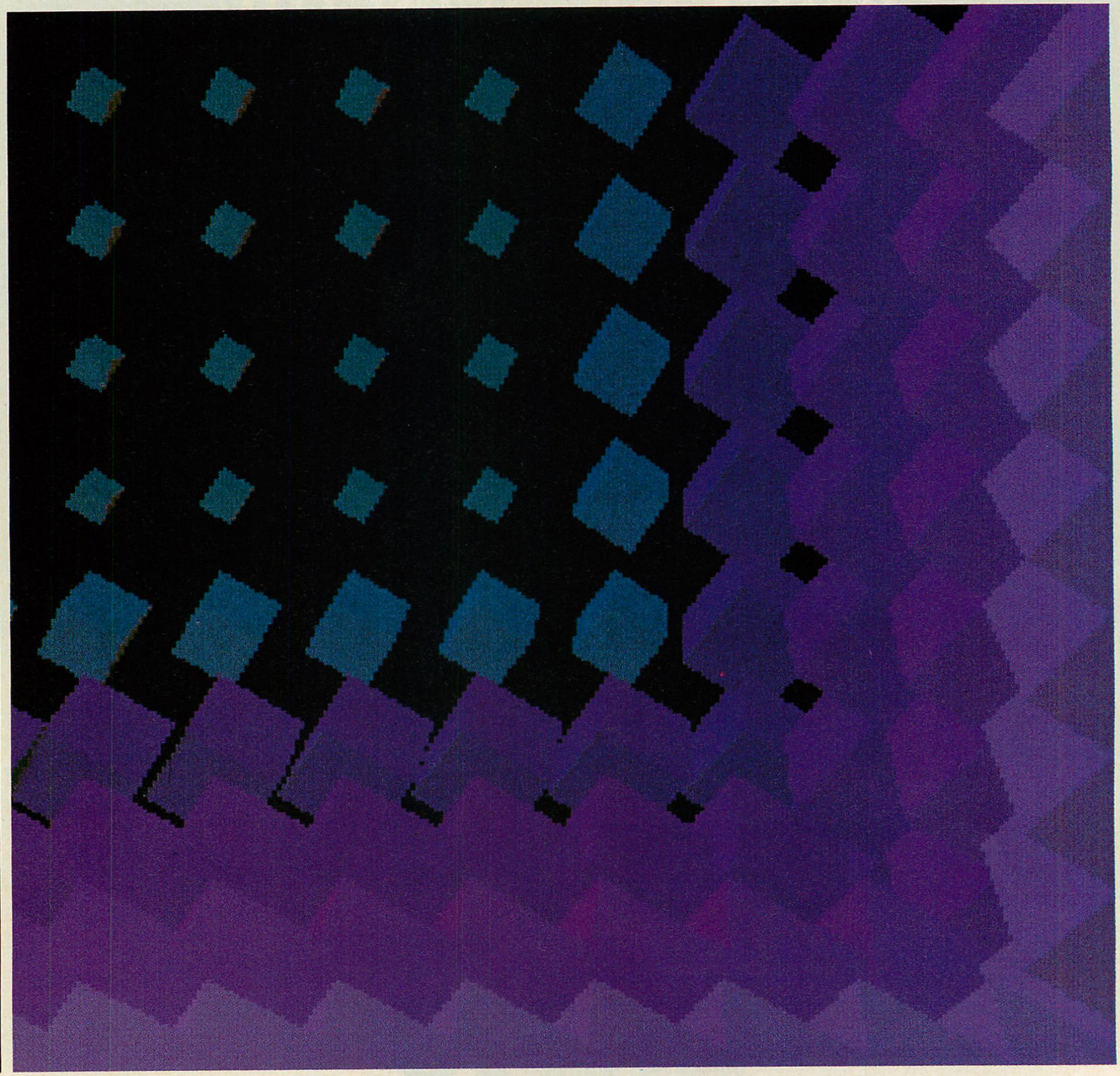
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Software products that are capable of quickly capturing media attention and market interest are as rare as hens' teeth, especially at a time when most new products seem to be greeted with, at best, a "ho-hum, what now?" attitude. There is a magic formula, however: two cups overflowing of venture capital, a dash of Ben Rosen, and a splash of public relations. This is precisely the auspicious launch that Paradox, from Ansa Software, received in September 1985. To be sure, it worked. Paradox was the darling of the press, received glowing reviews, and found its way onto most retailers' shelves. Now that the initial rush of excitement is past, the time has come to examine Paradox more carefully.

Ansa characterizes Paradox as a "new approach to relational database management that uses practical concepts from artificial intelligence," and says that it "combines the often promised but previously contradictory benefits of power and ease of use." These statements describe the essence of Paradox, but need further explanation.

Paradox is a *very* relational data manager. This peculiar statement simply means that Paradox conforms to the original Codd definition of the relational model of data management very tightly, a claim that other products often make but sometimes cannot support. Strict adherence to the Codd definition does not necessarily result in a product that is better; in fact, Paradox suffers in some ways because of its conformity.

The practical application of artificial intelligence is a bold claim—one that is hard to verify. Ansa means that certain techniques, products of AI research, have been embedded in its product. Discussions with Paradox's developers reveal techniques more akin to game theory, in which alternate strategies are developed and then analyzed to find the one strategy of highest value. Paradox uses these techniques to reduce its visual queries to procedural forms and to produce optimal strategies for carrying them out. Although Paradox is not the first data management product to include query optimization, its handling of queries is innovative.

Paradox is powerful not only because it is possessed of competitive performance but also because the all-important query facility is easily operated by the user. A software product is only as powerful as the user is able to make it; power that the user cannot find or understand goes untapped. This is not a problem with Paradox.

Ease of use is achieved in two ways. First, the program includes a Lotus 1-2-3-like menu interface. Users familiar with 1-2-3 will have little trouble migrating to Paradox, a fact that measurably improves the product's approachability. Second, and more important, Paradox eliminates the biggest headache associated with most data management products with its visual query-by-example metaphor. The user is free to concentrate on the conditions of the query and the desired goal rather than issues of command language syntax or ordering of phrases of the command to assure optimal performance.

USER INTERACTION

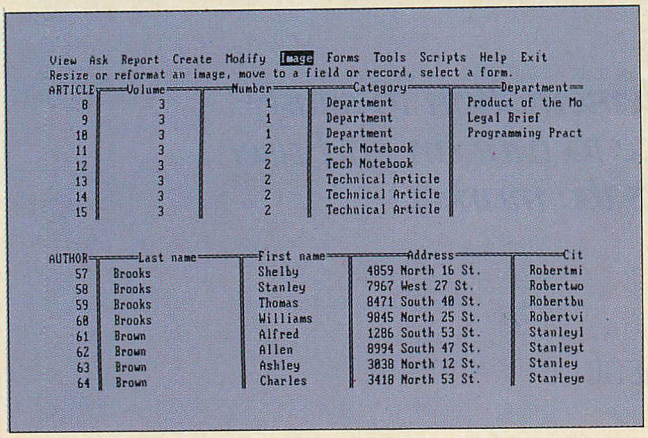
Beginning a *PC Tech Journal* data manager review with a discussion of end-user factors is unusual because these reviews are generally written from a developer's perspective. The target market for Paradox is primarily the end user, and the very nature of programs written in the Paradox Application Language is strongly affected by this orientation. In fact, to develop applications, programmers must know and understand the Paradox interactive environment in complete detail because (1) a direct correlation exists between the programming language and the interactive environment, and (2) some tasks are best done interactively, recorded as scripts (Paradox's version of macros), and later integrated into a program.

Paradox is copy protected with SuperLok, and it must be installed on a hard disk or invoked using a key diskette. The installation procedure is painless and automatic. Modifications to CONFIG.SYS are made, so the computer must be rebooted prior to running the program. Resident programs should not be installed when Paradox is used. This is not because Paradox interferes with such programs, but because it demands so much memory. During the course of this review, problems were encountered with both a 576KB PC (DOS 3.0) and a 640KB PC/AT (DOS 3.1) when resident programs were loaded. In both cases, Ansa's sample application aborted for lack of memory until all resident code was eliminated. The results were not consistent, presumably because of varying states of Paradox's virtual memory manager; therefore, it is recommended that users provide the program with maximum free memory.

On a hard disk, Paradox installs into a subdirectory called \PARADOX. Unless \PARADOX previously has been mentioned in a DOS PATH command, the program must be started with this as the default working directory.

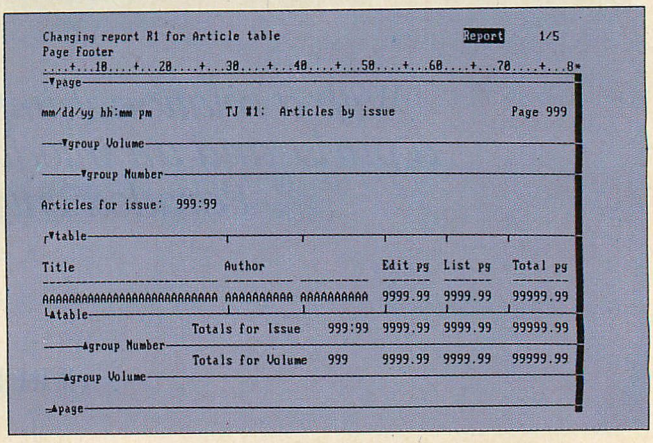
Once Paradox is running, the interactive user is confronted with a menu of commands across the top of the

PHOTO 1: *A Typical Paradox Screen*



Two table images are in view, and the Paradox menu has been activated. Unseen portions of the tables can be accessed by cursoring down or to the right, and the amount of screen space devoted to each table can be adjusted.

PHOTO 2: *The Paradox Report Design Tool*



One of the reports from the *PC Tech Journal* sample application is shown compacted to fit in one screen width. Although the screen seems cluttered, the report design tool is easy to use and makes intuitive sense.

screen (see photo 1). As with Lotus 1-2-3, the top line contains options while the second line contains a more detailed description of the selected item. A menu item may be selected by cursoring to it and pressing the Enter key or by pressing the first letter of its name. As each selection is made, further menus are presented until Paradox has collected enough information to execute the command properly. Commands usually result in some action being taken in the Paradox workspace.

A function key template is provided with Paradox, and the function keys provide some shortcuts for operating the program. The only function key that must be used is the menu key (F10), which activates the Paradox menu if it is not visible. Most users will quickly gravitate to the function keys because they are well-chosen and useful.

In Paradox's interactive mode, the rest of the screen under the menu is a window on the workspace. Upon request, Paradox places tables (data files), forms, and query forms in the workspace, several of which are also visible in photo 1. Actually, every item in the workspace is a table; Paradox attaches special meanings to certain kinds of temporary tables and treats them differently. Many such items can occupy the workspace at any given time, and as many as 16 tables can be open and active at the same time. The user may navigate from one workspace item to another and also may move around within each item. Items can be removed from the workspace, modified, or reorganized. Reorganization of the table view, accessed from the Image menu, is particularly useful when certain fields need to be viewed together; this can save the user much needless navigation.

Tables are simply and quickly created from the Create option on the main menu. The user is asked to specify field names (up to 25 characters, including blanks), field types, and the length of text fields. Paradox supports five data types. Alphanumeric fields may contain up to 255 characters and are fixed in length. Numeric fields can have up to 15 significant digits. Dollar fields are the same as numeric fields but are given the expected default display format. Date fields can contain dates from January 1, 100 to December 31, 9999, a range that should satisfy the most demanding application. Finally, short fields are integers ranging from −32,767 to +32,767; the manual suggests that users avoid this type and that they be used by programmers only. Any number of consecutive fields, starting with the first, can be designated as key fields for which Paradox will automatically maintain indices.

Tables also can be restructured, even after data have been loaded. Paradox presents the existing structure of the table to the user, who is then free to add or delete fields, change key field designators, change text field sizes, reorder the fields, or change field types. The reorganization of the data files is handled automatically, and the user is warned of any change that will cause a data loss. When the reorganization takes place, all Paradox objects (reports, forms, indices, settings, validity checks) also are changed as required; care must be taken because changing a field's type or deleting the field causes it to be deleted from all forms and reports or from formulas in calculated fields. The actual disk files containing data are reduced in size, if appropriate.

A table is stored on disk in a set of files with a common, user-selected file name and a Paradox-assigned extension. Paradox never requires the extension to be specified, and it properly maintains all files in the family. For example, if a table is copied into another table or deleted, all files in the table's family are automatically copied or deleted.

When the user requests a view of a table, it is presented in the workspace in tabular form. The operational similarity to spreadsheets is immediately obvious: records are displayed one per row, with each field occupying its own column. Most tables are too big to display on a single screen, but the workspace can accommodate tables that are too wide or too long, and the user has facilities at hand for navigating quickly to unseen areas of the table. Jumping from one table to another also is a simple matter; Paradox remembers the user's position in each table in the workspace and returns the user to that point when the table is reactivated.

A table displayed in the workspace can be interactively modified by depressing the Edit key and navigating to the fields to be edited. The user can make sweeping changes in edit mode, including adding or deleting entire records. While in edit mode, *any* item in *any* table in the workspace can be changed. When editing is complete, pressing the Do_It! key causes the changes to be retained, or the entire editing session can be undone by accessing the menu and selecting Cancel. Validity checks can be defined for each

field in each table and are active during the editing process. Paradox supports range checking, default values, table look-up, picture formats, and required entries. Validity checks apply only to edit mode and are not active for bulk loads or imports into a table.

Paradox is able to import or export data in various formats. Delimited ASCII, pfs, VisiCalc, 1-2-3, Symphony, and dBASE file types are supported. The import facility is particularly impressive because the Paradox table is automatically created for all file types except ASCII. A dBASE file can be loaded easily into Paradox, which is clearly a strong selling point for Ansa.

An easy-to-use form design utility is provided, and the user can ask to have records displayed one at a time on one of ten forms designed for the table. The form view entirely occupies the screen, preventing other tables from being viewed. Paradox automatically builds a standard form the first time the user asks for the form view, or custom forms can be designed beforehand and used on demand. When a form has been selected for display, the user can switch between the table view and the form view with one keystroke. Paradox keeps the form and table views synchronized, so that toggling between them leaves the user in the same position. For example, if the user is editing a field in the table view, toggling to form view places the cursor at exactly the same position in the field being edited. Editing from the form view operates in the same manner as editing in the tabular view, and validity checks, if any have been defined, are active.

The form design tool allows the user to create complex display formats of one or more screen pages. Text can be placed anywhere on the screen by cursoring and typing. Four types of fields can be placed anywhere on the screen. *Regular* fields display data that can be modified and placed on the form only once. *DisplayOnly* fields cannot be modified, and are especially useful to repeat previously displayed fields on subsequent screen pages. *Calculated* fields contain simple expressions using field names, arithmetic operators (+, −, *, /), and parentheses; field names in the expression relate to the current record of the table to which the form is attached. Calculated fields are not updated as other fields on the screen are entered, so a changed expression can be viewed only after the Do_It! key has been depressed. Finally, a special field type called *# Record* simply displays the record number.

A variety of editing functions are available in the form design tool, including erasing and moving. A nice touch is the Border option that allows boxes to be drawn around areas of the screen. Paradox allows the use of the single- and double-line drawing characters of the IBM extended character set, but the user can choose any displayable character. Text and borders can also be styled with high-intensity, blinking, reverse video, or color, if available.

If a table is copied into another table or deleted, all other files in the table's family are automatically copied or deleted.

The generation of reports is parallel to forms. Paradox automatically generates a standard report and saves its description for later use. This is a wonderful feature for the end user, who is not required to labor over producing a quick printed copy of a table. More complex reports can be designed with an excellent design tool, fully integrated into the main program, which allows both tabular and free-form reports to be constructed. Report formats can be designed for conventional reports, mailing labels, and even "hit-the-box" printing of various preprinted forms, such as invoices or checks.

Tabular reports can be grouped based on field values, ranges of field values (an aggregate of dates, for example), or simply in blocks of some number of records (which leaves a blank line after every, say, tenth report line). Control breaks are provided, as are summary (total, subtotal) and calculated fields. The width of the report can be greater than the width of a page of paper, and Paradox prints one page-width after another in such a way that they can be physically attached to one another if desired.

Control over the physical printing of the report is similar to that of 1-2-3, with extensions. The layout of the page, including the size of the paper, the organization of page-widths, and margins, can be specified. A set-up string can be specified, although Paradox is delivered with a set of predefined strings for various printers. Photo 2 shows a screen from one of the reports from the sam-

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ple application, devised by *PC Tech Journal's* editors for testing data managers (see below).

The report design tool is rich and functional, yet not overly difficult to use. It can hardly be described adequately here; 120 pages of the user's guide (30 percent of that manual) are given over to explaining the facility. The Paradox designers have poured enormous energy into a tool that delivers almost any kind of report imaginable without overloading the user. Visually, the design tool makes sense; users will be quick to grasp it and move on to its more complex features.

Forms and reports are limited in one respect. Neither can access fields from more than one table and each must be directly attached, by name, to a specific table. The multifile problem can be worked around, but the method is cumbersome; Ansa must certainly address this drawback. The company has promised the ability to deal with multiple tables in forms for this year; it has not commented about reports.

The attachment of reports and forms to specific tables is awkward, because it means that reports cannot be used on tables of another name even if the structure of the table is exactly the same. For example, Paradox produces a table called ANSWER as the result of a query. Suppose the user mounted a query on a table, asking for the answer to contain all fields from the queried table. In order for Paradox to use a report attached to the queried table to produce a report for ANSWER, the user must manually copy the report definition (called *borrowing*) to the ANSWER table and then invoke the report. A report that is permanently attached to the table ANSWER cannot be created because ANSWER is a temporary table, one that Paradox throws away at the end of a session or overwrites when a new query is executed; the reports attached to ANSWER vanish with it.

Paradox's inability to access multiple tables from forms and tables demonstrates the problem of its conformance to the pure, relational model. Make no mistake: any table structure desired can be generated by the query facility and subsequently output through visual forms or reports. Other products have eliminated the intermediate step of new table generation (part of the mathematical definition of a relational system) in favor of time- and space-saving shortcuts. At the very least, Ansa might have provided for less tightly coupled reports and forms. Paradox becomes considerably more complicated to use when multiple tables are needed in reports; why this should be the case in an expensive, relational product is, in itself, a paradox.

PARADOX QUERIES

Queries to tables are at the heart of Paradox's power. Most data management systems are notorious for the formal language they force users to understand in order to mount queries. A growing number of products incorporate a form of query-by-example (QBE), that allows the user to describe a query by pointing and providing an example of the desired information. Paradox includes a visually satisfying, fill-in-the-blanks query approach that is not only simple to grasp conceptually but also enormously powerful. That, coupled with the *inability* of the user to influence optimization (meaning the user does not have to worry about it), makes Paradox's query facility innovative. The standard relational operations of select, project, and join are all provided but are completely transparent to the user.

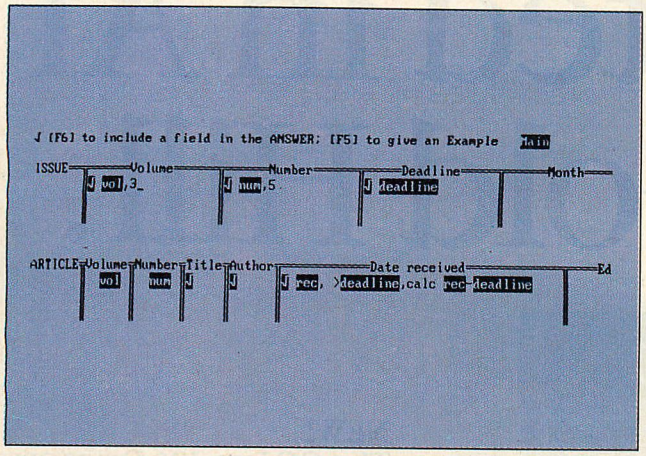
Photo 3 shows a typical, multitable query form in the Paradox workspace that illustrates its major components. (The query forms have been edited with the Images option for the purpose of having more fields visible in the photo.) The query form for a particular table resembles the table itself in that it has columns for each field of the table. The columns themselves are empty when a query form is initially presented to the user, who then fills in the desired columns with the elements of the request. When the query has been constructed, it is executed using the Do_It! key, which results in the creation of the table called ANSWER.

A typical query is composed of several elements, described here.

Check marks. A function key is used to insert or remove a check mark (using the square root symbol from the PC's extended character set) in a column. It means that the field should be included in the ANSWER table. A checkplus symbol (√+) means that duplicate values in a field are to be included; Paradox normally returns only unique values. If the check or checkplus key is struck while the cursor is in the leftmost area of the form (under the name of the table), all fields are selected.

Examples. An example is a special tag that allows the user to reference the field elsewhere in the query. It has no meaning other than to identify a specific field. At first the user might think that actual field names could be used; on reflection, however, certain ambigu-

PHOTO 3: *A Typical Multitable Query*



Examples are shown in reverse video, as are check marks. The vol and num examples establish the relationship between the two tables. The query forms have been adjusted using the Images command so more fields are visible. The saved form of this query is shown in figure 1.

FIGURE 1: *Sample Programmed Query*

```
; ADHOC7.SC -- Articles received after deadline
;

reset


@4,0 ?? "Enter the volume number:  "
accept "N" min 3 max 10 required to volno
@5,0 ?? "Enter the issue number:   "
accept "N" to issno


Query

 Issue |   Volume          |   Number          |  Deadline       |
       | Check ~volno,_vol | Check ~issno,_num | Check _deadline |
       |                   |                   |                 |
       |                   |                   |                 |

 Article | Title  | Volume | Number | Author last name |
         | Check  | _vol   | _num   | Check            |
         |        |        |        |                  |
         |        |        |        |                  |

 Article |           Date received                     |
         | Check _rec, >_deadline,calc _rec-_deadline  |
         |                                             |
         |                                             |

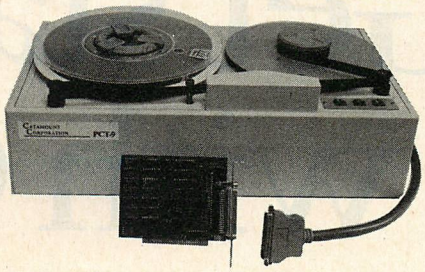
Endquery
do_it!


wait table
message "Press ESC when finished viewing results"
until "Esc"


return
```

The saved form of the query shown in photo 3, which includes everything between the key words Query and Endquery, resembles the visual form and can be directly included in a PAL program. Fields that are not referenced in the query are not included in the saved version. This program finds all articles received after the deadline.

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ities inherent in such an approach will be evident. Examples (reverse video in photo 3) are the means by which the user specifies how tables are related to one another for the purpose of queries; Paradox does not store permanent relationships in any way. In photo 3, the **vol** and **num** examples are used to establish the relationship between the two tables, while the **deadline** example is used in the condition and calculation in the Article table.

Conditions. To select certain values from a field, a condition may be specified. In the example of photo 3, the condition is in the Date Received field of the Article table and specifies selection of only those records for which the Date Received is after the Deadline. Conditions may be quite complex, and more than one condition may be used, even in the same field. Specifying multiple conditions in the same row means that all conditions must be met (a logical AND); they may be entered in additional rows of the query form (a logical OR). Conditions may be constructed that reference other fields using examples. Exact matching, pattern matching, and inexact matches (*like Reader's Digest* will find a record that is missing the apostrophe) significantly extend query power.

Calculations. The CALC key word creates new fields or summaries for the ANSWER table. New fields are created by following the CALC key word with an expression using examples. For example, if example name *p* has been given to a price field, a mark-up field can be created with the expression CALC *p* * 1.20. Summaries are created by following the CALC key word with one of five *group operators*: AVERAGE, COUNT, MAX, MIN, or SUM. Care must be taken with these operators; COUNT, MAX, and MIN deal with unique values, and AVERAGE and COUNT do not include empty fields. This is a handy feature for AVERAGE, because it can be used to average only fields with data; COUNT, however, can produce unexpected results until the user gains familiarity with the system. Note that an empty numeric field in Paradox is *not* equal to 0. In the example of photo 3, the calculation creates a new field (seen in the ANSWER table below it) that shows the number of days late.

Operations. Four table operations can be carried out through the use of a query: INSERT, DELETE, CHANGETO, and FIND. INSERT adds records from one table to another when the structures of the two tables are different. DELETE removes records matching the conditions from a table. CHANGETO allows in-place modification of fields in tables and, in conjunction with other query facilities, is extremely powerful. FIND allows the user to position to a specific place in a table. When these operations are used, the ANSWER table is not created. Instead, INSERT, DELETE, and CHANGETO create tables named INSERTED, DELETED, and CHANGED, respectively, while FIND brings the named table into the workspace with the cursor at the queried row. If one of these operations goes awry, the resultant table can be used to back the operation out. For example, the DELETED table can be used to replace the records via the INSERT operation.

Of all the features of Paradox, queries require the most study and experimentation, especially for those who will build applications.

Queries command a significant portion of the *Paradox User's Guide* (52 pages, about 13 percent). Most of this excellent coverage is given over to examples and tutorial information; this is appropriate because the basic concepts underlying the query facility are simply stated. However, the simplicity of the concepts should not be translated into ease of understanding. Of all the features of Paradox, this is the one that requires the most study and experimentation, especially for those who eventually will build applications. Complicated applications demand complex queries involving multiple tables and many conditions. The Paradox user and programmer must have an intuitive and natural grasp of the query system; practice is needed, because some queries that seem to make sense do not generate the intended result.

Queries are optimized automatically by Paradox. According to the developers of Paradox, the visual query is converted to a procedural algorithm. In fact, several procedures are devised when alternate strategies suggest themselves. These procedures are then analyzed to determine which one will result in the best execution time. The strategy selected may even involve the automatic creation of a secondary index if appropriate. The strategies devised by Paradox also take into consideration the

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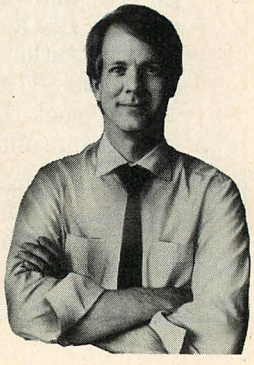
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current state of the system. For example, a current secondary index may already exist, making strategies requiring it even faster, or certain data may already be in memory, which might affect the order in which parts of the algorithm are executed. None of this is ever evident, and procedural thinking is required of the user only when sequential queries are necessary.

PROGRAM DEVELOPMENT

Interactive users of Paradox have at their disposal a facility called Scripts. At first glance, a *script* might seem to be nothing more than a macro—a method for recording, saving, and executing a series of menu selections automatically. In fact, the Paradox documentation seems to foster this superficial, but not inaccurate, view. Herein lies a strong feature of Paradox.

Sooner or later, the user of a fully featured data management package will want it to perform more of the operational steps that make up an application. If this were not the case, simple file management programs would meet the needs of most users. The step from interactive use to programmatic use is sometimes large, however; witness the vast array of publications on dBASE, most designed to get users over that hump. This volume of published information clearly indicates that even end users reach the point at which they believe programming is inevitable.

Ansa appears to have realized this fact. Paradox's programming language PAL (Paradox Applications Language) is somewhat hidden behind the Scripts facility, but users of Scripts will soon discover that they are learning how to program in PAL. This is so because each script is recorded and saved by Paradox as a syntactically correct PAL program that can later be joined together to form a complete, more automatic system or used as the basis for a more complex application. Paradox goes further yet, by providing both a text editor and debugging facility for use by program developers. A perfectly reasonable PAL program can be built by doing nothing more than recording interactive keystrokes into small Scripts files, then stringing them together with the editor. In effect, users need not be confronted with the tension of programming but will end up doing so anyway, and with relatively little pain.

The designers of PAL clearly intended to remove much of the complexity of traditional procedural languages while at the same time delivering considerable power to the program-

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mer. This is evidenced by such features as the lack of variable declarations (except for arrays); fully bracketed control structures with mnemonically useful key words (such as ENDIF), but with the *lack* of unnecessary begin/end constructs; and insensitivity to case and statement format. The language is supplemented with a rich and powerful library of functions; during construction of *PC Tech Journal's* sample application for this article, only one function (elapsed time) needed to be written.

A script is the basic element of a program and may contain directly executable code or procedure definitions. Procedures are defined with the PROC command, are named, and can have formal parameters. A script can be thought of as just a subroutine call. It is invoked by the PLAY command; when the called script executes a RETURN command, control is returned to the next command after the PLAY.

Scripts are read from disk and interpreted on demand. Running scripts is obviously subject to the system's I/O performance, but Paradox is suitably *fast* even on a PC-class machine, and the delays are not obtrusive. Procedures are compiled to a more optimal internal form for faster execution and permanently stored in memory. This is the only optimizing factor the Paradox programmer must weigh, and it is, unfortunately, important. Paradox is extremely memory-intensive, so leaving procedures defined in memory can reduce the size of the workspace and therefore affect system performance. C or Pascal programmers must discipline themselves to write most code as scripts and resort to procedures only if absolutely necessary. Releasing procedures from memory when possible is recommended by the manual, but caution is required because the RELEASE command removes *all* procedures.

Parameter passing to procedures is call-by-value, with a twist. Code in the body of the procedure can reference parameters, as might be expected, but the formal parameters also may be assigned values within the procedure without any effect on the actual parameter passed. Formal parameters have a scope restricted to the procedure only, and effectively vanish when the procedure completes execution. The PRIVATE command can be used in a procedure to make other variables local to the procedure; otherwise, variables are always global to the entire program. Functions are not explicitly declared in PAL; the RETURN command can be used to return a value from a procedure.

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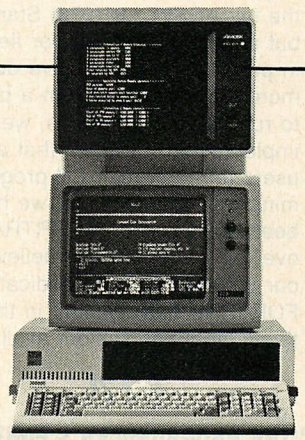
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PARADOX

The control structures IF, WHILE, and SWITCH are provided. IF and WHILE are quite standard and clear. The SWITCH command is Paradox's case statement, which is more general than its counterpart in C in that each case may have its own, independent condition. A further looping construct, called SCAN, allows a group of commands to be applied to each record in a table and further allows conditions to be specified for the selection of particular records. SCAN is an escape valve: if PAL cannot do the operation on a table directly, the programmer still receives help from the language.

Outside of the control commands, the only others without counterparts in the interactive side of Paradox are those for output, input, and variable manipulation. PAL uses @ to position the cursor on the screen and ? and ?? to write to the screen. MESSAGE displays text in the message area of the screen (lower right corner), which will vanish at the next key press. TEXT displays a block of text on the screen and is a handy (and speedy) way to get multiline messages out. PRINT directs its output to the printer or to a file, and the PRINTER command causes subsequent screen output to be echoed to the printer.

The ACCEPT command is used interactively to input one item of information. It is very powerful because it optionally allows all the Paradox validation checks, including DEFAULT. ACCEPT is not completed until the entered value meets the conditions for validity, so Paradox can do a lot of work for the programmer. Because variables are untyped, the ACCEPT syntax requires a type specification, one of only two places in PAL that this is the case.

The WAIT command temporarily returns limited control to the user, who can interact with a table in the workspace. Options on this command restrict the user to a FIELD, RECORD, or TABLE; under no circumstances is the user allowed to navigate to other tables. Interaction with the table can be limited to browsing, or the user can be allowed to modify the table by selecting edit mode under program control. The syntax of the WAIT command also includes a clause that specifies which key depressions are to end the interaction and return control to the PAL program.

Applications that mimic the human interface of Paradox can be built with SHOWMENU, another command that performs a lot of work for the programmer. Its syntax includes menu choices, which are listed on the top line of the screen in Lotus 1-2-3 fashion, and

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prompts, which are explanatory messages displayed when the menu item is selected. Execution of the SHOWMENU command causes the menu to be displayed, control to be returned to the user for the selection of an item, and assignment of the selected item to a specified variable. The variable may then be examined by the program to determine the choice; the SWITCH command is the most effective way to act on the choice.

Assignment in PAL is straightforward. The equal sign is the operator. The left side of the assignment is a variable name (including an array name), and the right side is an arbitrary expression. The variable is typed automatically based on the expression's type and can become any of the five data types allowed in records: alphanumeric, numeric, dollar, data, and short. Assignment is the only way to type variables.

ARRAY CHARACTERISTICS

Arrays have some special characteristics. First, PAL allows elements of the same array to hold different types. Two special commands, COPYTOARRAY and COPYFROMARRAY, are used to move all fields from a record into an array and back again; these commands are shorthand for an operation very common in data management applications and reduce the number of assignment statements. Second, arrays must be declared so they can be dimensioned, although COPYTOARRAY automatically dimensions the array to fit the number of fields in a record. COPYTOARRAY also associates field names with array indices, so that references such as ARRAY ["Cust ID"] are valid. Finally, an array can be emptied by redeclaring it.

Variables, including arrays, can be released from memory with the RELEASE command. All variables, or specific ones, can be eliminated in this way. Just as procedures should be released to free memory, variables and arrays should not be allowed to collect.

Expressions in Paradox are conventional. The programmer must be aware of types, however. An expression of mixed types results in an error, and Paradox terminates execution of the script. The most likely causes of type errors are expressions that the programmer intends will resolve as strings but, in fact, contain some other component. A number of supplied functions force type conversion; in practice, some experience is required before the programmer will be error-free.

Because everything that happens in Paradox occurs in the workspace, the

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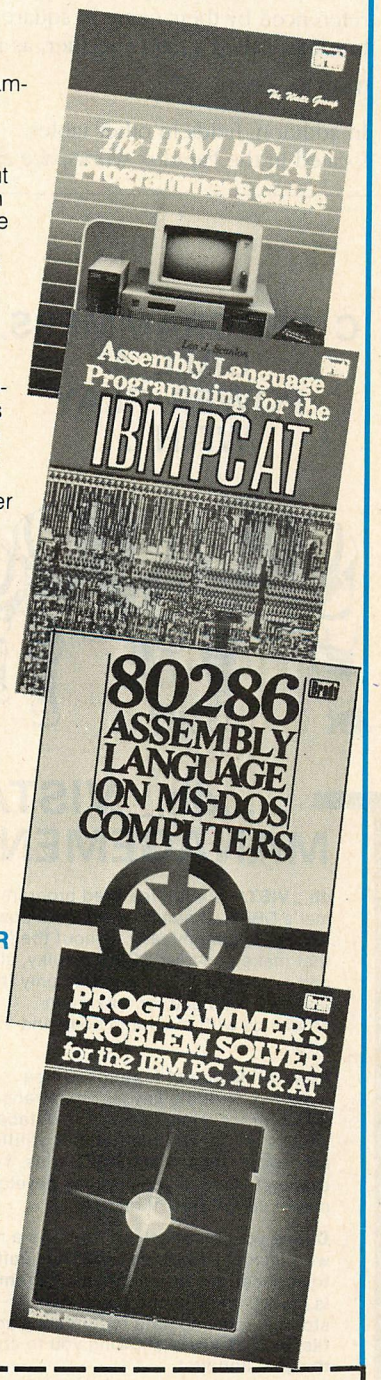
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programmer can access only the data in tables that have been opened (placed in the workspace). The presence of the cursor in a record in the workspace makes that table and record current, and PAL provides syntax to reference the components of the current record directly. Fields in the current record are referenced by their name in square brackets, called a *field* specifier, as in

[Date Received]

In addition, fields in other tables located in the Paradox workspace can be referenced with an extension to the syntax, such as

[Article → Date Received]

which mentions the table name. If the same table is in the workspace more than once, the table name must be subscripted. The subscript follows the table name in parentheses and usually will be a small integer, meaning the *n*th table; the letter *Q* also can be used to reference the contents of a query form.

This freedom to get to any field of any table in the workspace means that the programmer can overcome the single table limitation of forms and reports by writing extensive PAL code to manage custom forms and reports. Most Paradox users are likely to opt for building intermediate tables (unless their size is prohibitive) and using the built-in forms and reports. Building screen forms is easier than in most other data managers, because the ACCEPT command can do all of the field work. The programmer just has to manage output and cursor position.

All other commands in PAL fall into these three categories: queries, menu sequences, or PAL shorthand for menu sequences. Queries are just as visual in PAL as they are on the display and, once understood interactively, pose no obstacle to programming. The single extension to queries in PAL is that variables may be placed in the query form; when the query is executed, the contents of the variable are used as part of the selection criteria. Variables in queries must be prefixed with a tilde (~) to distinguish them from other query elements. Items that are not prefixed in this way are taken literally.

Building interactive queries is an important skill for PAL programmers to learn because it is the easiest and quickest way to build queries for incorporation into a program. PAL demands a rigid syntax for these queries and is unforgiving about errors. Using Paradox to build them, however, assures accuracy and provides the programmer a framework within which to make additions or modifications.

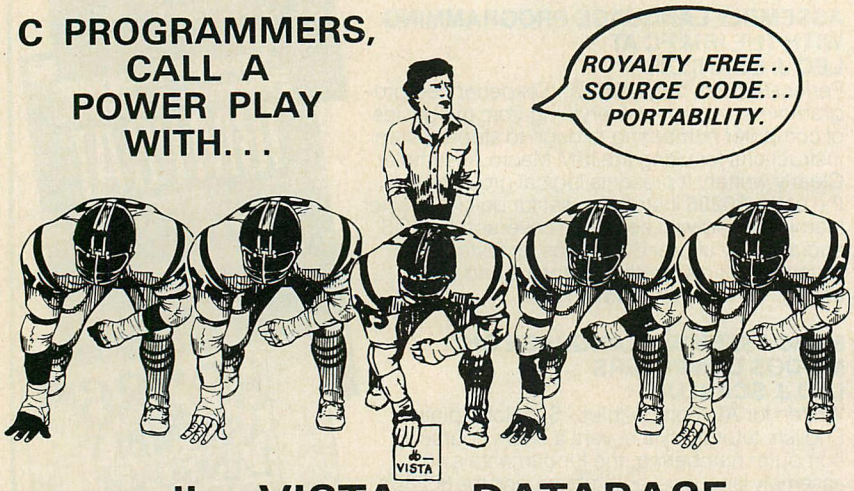
Paradox saves queries as ASCII text files. The saved query from photo 3 is shown in figure 1. Note that the saved query (from Query to Endquery) has been embedded in a program. In the saved form, the visual check mark has been replaced by a word, and examples are prefixed with an underscore. Notice also that blank lines are inserted after the key word Query and before the key word Endquery; if these lines are eliminated, PAL returns a syntax error. This is but one example of the language's sensitivity to query layout.

Menu sequences are nothing more than a list of selections from the interactive menu in their proper order. The menu selections are enclosed in curly braces. Listing them in a PAL program is equivalent to moving through the menu interactively. For example, to delete the table FRED, the program might contain

```
MENU {Tools} {Delete} {Table} {FRED} {OK}
```

Such sequences can be arbitrarily long, and they can be interspersed with pro-

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FIGURE 2: *Example of Menu Sequences*

```
; BENCH5.SC
; script to find all authors from California and export a
; delimited ASCII file of those records in ZIP code order.
;
; Even though the operation is performed assuming the presence of
; indices from BENCH2, BENCH4 modifies the AUTHOR table and thus
; obsoletes the secondary index, which is not automatically
; maintained by Paradox.  Therefore, this benchmark is run twice.
; The first one will build the secondary index, and the second
; will simply use it.

; Run #5 assuming that indices will be rebuilt
reset
@row()+1, mar  ?? "#5 -- California Authors  "
  markstart()
    Menu {Ask} {Author}
      CheckPlus Right Right Right Right Right "CA" Do_It!
    Menu {Modify} {Sort} {Answer}
      {Same} Down Down Down Down Down  "1" Enter Do_It!
    Menu {Tools} {ExportImport} {Export} {Ascii} {Delimited}
      {Answer}
        if isfile("caauths.txt") then {caauths.txt} {Replace}
                                 else {caauths.txt}
        endif
  markstop()
  reportdt()
  clearall

; Run #5 assuming the presence of valid indices
reset
@row()+1, mar  ?? "#5a-- California Authors  "
  markstart()
    Menu {Ask} {Author}
      CheckPlus Right Right Right Right Right  "CA" Do_It!
    Menu {Modify} {Sort} {Answer}
      {Same} Down Down Down Down Down  "1" Enter Do_It!
    Menu {Tools} {ExportImport} {Export} {Ascii} {Delimited}
      {Answer}
        if isfile("caauths.txt") then {caauths.txt} {Replace}
                                 else {caauths.txt}
        endif
  markstop()
  reportdt()
  clearall

return
```

Listing menu sequences in a PAL program is equivalent to moving through the menu interactively. The menu selections are enclosed in curly braces. Such sequences can be arbitrarily long and can be interspersed with program logic.

gram logic. For example, many interactive sequences differ at the point that the presence or absence of an object is determined. Just before Paradox makes the determination, the sequence can be altered with an IF statement that performs the check and then supplies the correct sequences depending on the result. An example is shown in figure 2, which is the code for *PC Tech Journal*'s benchmark to extract records to create a text file (see table 1). Here, the records of authors who live in California were extracted.

The menu sequence syntax makes PAL simple to grasp for the novice but will quickly exasperate experienced programmers. Once again, Paradox designers have anticipated this and have provided shorthand for most of the important sequences in the language. The programmer is thus more likely to use the DELETE command, which unconditionally removes a table if it exists, than the more cumbersome menu sequence with its requirement for embedded logic. A serious weakness of PAL is that not all menu sequences have shorthand, so the programmer must resort to writing these sequences from time to time. The construction of *PC Tech Journal*'s sample application required some operations for which a short form did not exist. On the other hand, sequences allow the programmer access to *all* features of the system.

One special command that falls into its own category is EXECUTE, a subtle but extremely useful and powerful feature of PAL. EXECUTE allows a string to be executed as if it were a PAL command itself. This means that the

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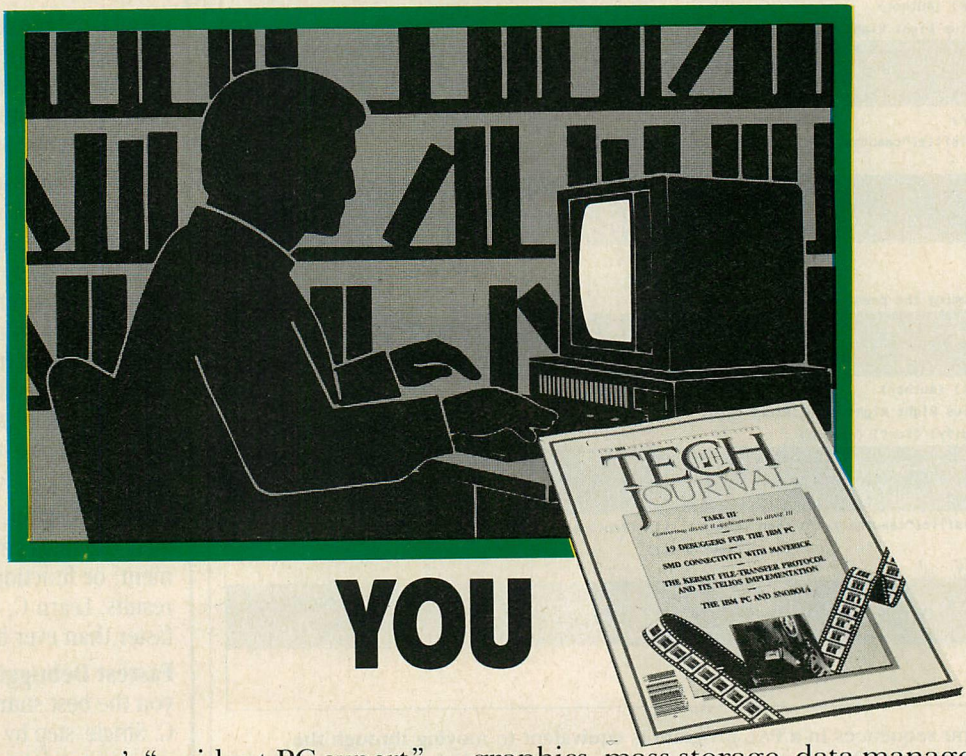
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programmer can build PAL code on the fly, as in the following example:

```
EXECUTE "PLAY \"bench" +
  strval(number) + "\""
```

Assume that the program has previously obtained a number. The expression above concatenates the number to the word *bench*, which then becomes the argument for a PLAY command. The backslash character (an unfortunate choice) is used as the escape character to insert special characters in strings.

The PAL language is enriched by an extraordinarily well-thought-out set of built-in functions. These handle financial, mathematical, and statistical calculations, date and time, input/output, string manipulation, system status, and workspace status. The very extensive latter category includes functions such as ATFIRST (is the current record the first record?), FIELD (the name of the current field), and ISFORMVIEW (is Paradox currently in the form view?). The string functions are very complete and useful, a significant strength over other products. MATCH, in particular, is capable of such feats as extracting the first and last name from the *lastname, firstname* construct so often encountered; it can do so in a single command.

Listing 1, the main program from which *PC Tech Journal's* sample application's benchmarks were run, demonstrates some representative PAL code: menu creation with the SHOWMENU command; case statements; writing text to the display; waiting for user input; and the EXECUTE command.

PAL PROBLEMS

In practice, the language has a few problems. A notable omission from the design is support for system features. The user cannot (interactively or under program control) go to DOS, perform a command, and return. This might not be so bad if it were not that PAL is very limited when it comes to overall system control. For example, a DOS file cannot be deleted or renamed, although the ISFILE function allows the programmer to determine if the file exists. Paradox provides those functions it needs for itself (it can delete a table, form, report, etc.) but nothing else. If the Paradox environment is too confining for the task at hand, the programmer is simply stuck. Other programs or modules cannot be attached to PAL code. PAL is a closed system; if the capability is not included, the user cannot get it.

Development of PAL programs is supported with a script editor and debugger. The editor is rather simple; most programmers will opt for their favorite, using the built-in facility only to make small changes. The editor is also the source of the only outright bug found in Paradox: password-protected scripts can be read into the editor without giving the password. Ansa already has fixed the bug for its first update, which is expected shortly.

The debugger is also simplistic, but does allow single stepping through PAL code and provides the very interesting **where** function, which allows the programmer to see the nesting of script and procedure calls. When in the debugger, the user can abort execution of the script or transfer control to the editor, which automatically loads the script and places the cursor on the PAL statement causing the problem.

Finally, ample source code, in the form of a sample application, is supplied with Paradox to demonstrate the many language features that are available. This is a blessing, because the PAL documentation is the one weak point in an otherwise distinguished manual set. At first reading, the *PAL User's Guide* seems complete. The manual is organized with introductory sections that

TABLE 1: *Benchmark Results*

BENCHMARK TASK	TIME (secs)
Add 900 records to an empty database	53
Index database on two fields (7 bytes)	58
Document and tally codes from one field	34
Mass change of one field (28 records of 900)	34
Extract selected records to create a text file	
When secondary index must be created	37
When secondary index is available and current	11

The standard *PC Tech Journal* benchmarks gave these results for Paradox, which are competitive with other data managers. Data import is the fastest time recorded so far in this series of reviews of data managers. Paradox performance is actually better than these figures seem to indicate (see text).

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explain the language, followed by two alphabetically organized reference sections for PAL commands and functions. Therefore, finding information about a particular command is easy. Finding more general, but still vital, information about the language is very difficult. The index has no reference to string concatenation; in fact, there is no description of the topic in the entire manual. Whatever the programmer learns about the concatenation of strings comes only from implication by way of examples in the book. The manual also could use a better explanation of data types and how typing actually works. The index might be the culprit here; more entries would be helpful. In general, the descriptions given for the PAL commands and functions are good to very good, while the description of the language itself is only fair.

Ansa has provided a reference card for PAL, but it too leaves something to be desired. Its worst feature is that it is organized just like the manual, with two alphabetical sections. The best reference information is contained in lists at the beginning of each section of the reference manual, which are organized by functional group. The reference card would be much more useful if it were organized in that way.

In general, PAL exhibits the best features of a variety of contemporary languages and demonstrates the knowledge and thoughtfulness of the developers. It is well integrated with the interactive environment and functionally complete. Its only weaknesses are its manual and the lack of facilities for connecting with DOS.

THE SAMPLE APPLICATION

The database developed by *PC Tech Journal* for testing data management products contains three files holding information about magazine issues, articles, and authors. The application involves the creation of forms, reports, and various manipulations of the files. (For a complete explanation of the sample application, see "Sample Application Specifications," August 1985, p. 48. The article and sample data files are also available on PCTECHline.)

The sample application posed no serious obstacles to Paradox and its programming language. In fact, most of the work was quite straightforward. The approach taken with the coding was in the spirit recommended in the PAL manual, and it was assumed that typical developers would put certain parts of the application in PAL code and leave other tasks for interactive use.

Creating the data files was to the letter of the specification, with two exceptions. The ASCII data files supplied by *PC Tech Journal* include many city names longer than the specified length of 16 characters. When Paradox detected these records, it refused to import them and placed them in another temporary table called PROBLEMS. Unfortunately, the PROBLEMS table is not very helpful because it does not identify the reason Paradox rejected the import record. Furthermore, Paradox places only the first 80 characters of the rejected ASCII line into the PROBLEMS table as an alphanumeric field. Most of the rejected records were therefore truncated and not useful. Increasing the size of the City field allowed the import to run to completion; if desired, the loaded table can be restructured to reduce the field size back to 16, with truncation of long entries.

The second exception is that Paradox does not support logical fields. The single logical field required by the sample application was handled by specifying it as an alphanumeric field with

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PARADOX OVERVIEW

PARADOX, version 1.0
Ansa Software Corporation, 1301 Shoreway, Suite 221, Belmont, CA 94002-9990; 415/595-4469

Product type. Relational data management system with an innovative visual query-by-example feature; applications development system; and programming language for business use. Paradox is characterized by a good human interface, a strong relational model, excellent documentation, and a thoughtful design.

IBM PC environment. IBM PC, PC/XT, PC/AT, Compaq, Compaq Plus, Deskpro, and other 100-percent IBM-compatible computers. Runs under DOS version 2.0 or higher. Requires 512KB RAM (640KB is recommended). Requires two diskette drives or a hard disk and one diskette drive.

Other environments. No other systems are supported.

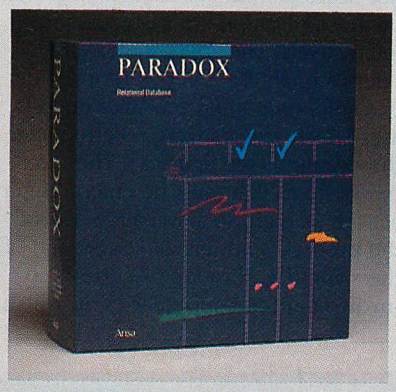
Network support. The product provides no specific network support in the initial release. Ansa has stated its intention to deliver a network version of the product sometime in 1986.

Copy protection. The program uses Softguard Systems' SuperLok and is delivered with two master diskettes, each of which has one install. The program operates from hard disk with no key disk required.

Documentation. *Introduction* (150 pages), *User's Guide* (399 pages), *Paradox Applications Language (PAL) User's Guide* (249 pages), *Quick Guide for dBASE Users*(22 pages), and *Quick Guide for Lotus Users* (17 pages). Pull-out reference card for PAL as well as rigid and flexible function key templates are provided. The large manuals are spiral-bound and lay flat when open. They are very well designed and provide many excellent diagrams and examples. Programmers may find the PAL manual insufficient and its index unsatisfactory.

User interface. The program is menu-driven with a menu structure that strongly resembles that of Lotus 1-2-3. Macros (which are called *scripts* by Paradox) can be recorded for playback at a later time. Tables are viewed and manipulated in a tabular form that resembles a spreadsheet.

Help facilities. An on-line help system displays screens of environment-sensitive information; assistance in the exact context is limited. Navigation to



help with other topics is provided. This on-line information lacks depth and the manuals are needed during the learning phase.

File limitations. 255 characters per field; 255 fields per record; 4,000 characters per record; and 65,000 records per file. Maximum table (file) size is approximately 260 million characters. The number of tables on disk is limited only by physical disk capacity. Paradox can access a maximum of 16 tables simultaneously.

Field types and limitations. Alphanumeric: 255 characters. Numeric: 15 significant digits, including decimal places. Dollar: same as numeric, with the exception of a default output format; numbers are rounded to two decimal places. Date: ranges from 1/1/100 to 12/31/9999 and can be manipulated arithmetically. Short: integers between -32,767 and 32,767.

Data entry. Data can be loaded into tables in bulk, from other files or tables, or interactively, one record at a time. Validity checks are applied only to interactive entry and include data ranges and table look-up. Fields can be designated as required, can offer a default, and can have a BASIC-like picture associated with their format.

Applications development facilities. Paradox provides an extensive programming language (PAL) that is consistent with the menu-driven nature of the interactive system. Saved queries and scripts can be integrated directly into a PAL program. A program editor, debugger, and trace system are standard parts of the system.

Security. Password protection is provided for data files and programs. Protected data are encrypted.

Access to system facilities. Paradox is a closed environment, providing operating system services only to the degree required to perform its function. Direct access to the command processor is not provided.

Query and sorting. An innovative query-by-example (QBE) facility is provided. Extremely complex queries can be constructed using a simple and straightforward query form; the query can be conditioned upon data from multiple fields and multiple tables. Queries can be saved, recalled for use later, and integrated in the programming language. Paradox always presents tables sorted across all columns (fields), but the order can be modified specifically with a sort option.

Reporting. Tabular and free-form reports are supported. A rich design tool for reports is integrated with the system: up to 10 reports can be defined for any table. Reports can contain summary fields (such as subtotals and totals), calculated fields, headers, footers, and pagination. Control breaks are simply defined. Reports can be sent to a printer, the screen, or a file. Reports are attached to a specific table, so data from multiple files cannot be provided in a report unless a previous query has constructed a table containing all required information and a report has been designed for the resultant table.

Utilities. The functions provided include deleting, copying, or sharing tables, forms, or reports, examining disk directories, and changing the disk directory. Tables can be emptied of data, and records can be added to or subtracted from tables.

Data compatibility. The program can import or export files from or to dBASE II/III, Lotus 1-2-3, Symphony, pfs, and VisiCalc. Delimited ASCII and text modes also are supported for import and export operations.

Distribution. Began in October 1985.

Price. $695.

Support. The product includes sample data files for use with the tutorials contained in the manuals. A sample application is provided, complete with source code. Registered users can obtain telephone support and upgrades at special prices. Replacement of defective media is free during the 90-day warranty; thereafter, the cost is $25. Ansa warrants that the media are free of defect, that the program is properly recorded, and that the program operates as described in the manual.

—WF

validity checks. A look-up table was created with the two values YES and NO, and the field was marked for required data entry. This scheme assured that the field would be filled with one of the two allowed values.

The only part of the application that could not be done without extensive programming was the data entry screen, which specifies three fields that must be obtained from other tables. The problem, as previously described, is that Paradox forms can display data from only one table at a time.

Actually, once the report formats have been defined, a program is really not necessary. All the features required by the application are easily obtained interactively. The application's ad hoc queries might be faster as scripts. For example, one of the specified queries asks which articles were received after the deadline (see figure 1). The number of items that must be entered interactively is high, so automating part of the process is advantageous. Several of the sample application's queries also involve multiple-step queries, in which the answer can be obtained only by a second query against an ANSWER table. These queries are simpler to use under program control as well. All seven of the sample application's ad hoc queries were written in PAL and none posed any problems.

The *PC Tech Journal* benchmarks were quickly programmed in PAL; no difficulties were encountered. The only extra work required involved the creation of functions to calculate elapsed time, but these were not complicated.

The results of the benchmarks are shown in table 1. The import of data is very fast; other functions are competitive with other products. Some special explanations are required. The last benchmark is shown twice, with two different times. The specification for this benchmark states that, because the benchmarks are to execute in order, the index for the Author table will be present for use by the subsequent benchmarks. However, Paradox does not automatically update secondary indices, so the fourth benchmark, which modifies the Author file, leaves the secondary index out of date. Paradox sees that a secondary index will help the fifth benchmark and thus regenerates it. The first time shown reflects this index generation. If the benchmark is run a second time right after the first, the secondary index is still valid and no time is required for its generation.

The benchmarks do not reflect Ansa's claim that Paradox performance excels in situations where table manipulations are based on queries associated with key fields—that is, those having primary indices. Their claim is supported by their own demonstrations. The *PC Tech Journal* benchmarks demonstrate secondary index performance, on the assumption that many queries will operate on fields other than the primary key fields.

HERE TO STAY

In Paradox, queries are relatively easy to construct and require no procedural analysis by the user. Paradox does all the optimization and produces a result. Few products offer that kind of power at the user level, and most require either some thought to make the query optimal or some programming.

As a product for the end user, Paradox excels. It delivers on its promises of ease of use and power. It is nicely documented and designed and is functionally complete. Paradox's features are well-integrated, its operation is consistent and often intuitive, and it is helpful when problems occur. At $695, Paradox

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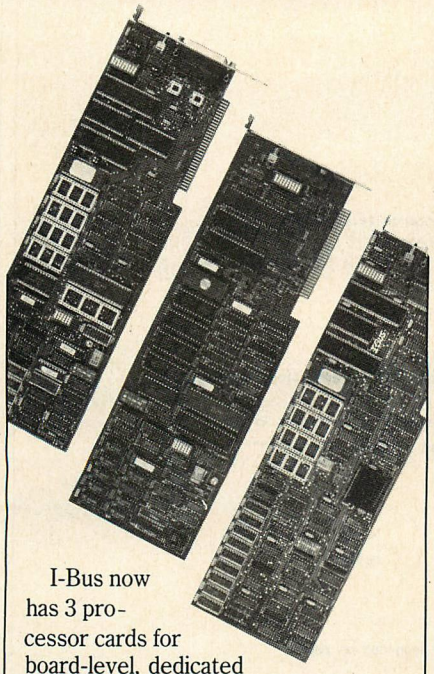
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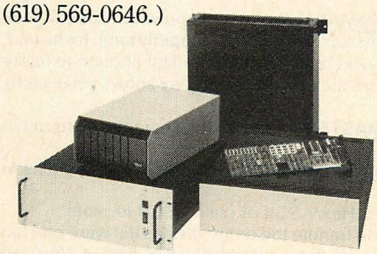
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is expensive for the end user, but no other product offers such an accessible, powerful query facility.

As an applications development tool, Paradox is a questionable choice at the moment. To begin with, it is copy protected and carries those headaches. The current product does not provide support for multiuser applications, checkpoint/restart capability or logging for audit trails, transaction processing, or the ability to rebuild damaged files. The language is restricted in its support of DOS operations, and other languages cannot be connected to PAL applications. Finally, no runtime option is offered, making the cost of the first application delivered quite high.

Ansa has told *PC Tech Journal* that version 1.1 will be released soon and will be available to current owners for a nominal charge. Details are sketchy, but a spokesperson said the new version will have improved memory and resource handling, better performance, forms that access multiple tables, access to DOS functions, more report generator features, optional automatic creation of tables for ASCII import, an incremental UNDO capability for edits, and the ability to release procedures by names. These are significant improvements, many of which address criticisms made in this review; more is needed before applications developers will be completely comfortable with Paradox.

On February 3, Ansa announced a developer support program to be available starting in April. The program costs $250 and includes a toll-free telephone support service, a quarterly newsletter, and the Paradox Developer's Tool Kit. The toolkit includes several PAL utilities (data dictionary, menu generator, damaged file recovery) and a number of subroutines written in C that can read and write Paradox files. Also announced was Paradox Runtime, which will be distributed to registered users for a fee of $9.95 and will allow up to 250 copies of a PAL application to be distributed with no royalty fees. At the time of the announcement, Ansa was unsure of its plans for developers who wish to go beyond the 250-copy mark. These newly announced programs and products clearly address some of the more severe criticisms presented here.

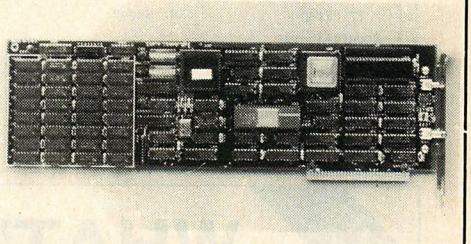
Given the excellent user factors, Paradox and Ansa are probably here for the duration. The signs are now hopeful for good developer support. In the meantime, Paradox's innovative and powerful query facility is likely to woo and win many users, giving Ansa a solid base upon which to build.

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LISTING 1: BENCHMKS.SC

```
; BENCHMKS.SC
; PC Tech Journal Data Manager Template Benchmarks -- Main Program
; Will Fastie -- 12/16/85
; Edit:  12/20/85 1020

clear
clearall
title = format("w80,ac", "PC Tech Journal Data Manager Benchmarks")
@2,0
style reverse
?? title
style
@4,0
text

     This program automatically runs the five benchmarks specified
in the Software Review Specification for Data Management Products.

     Start, stop, and elapsed times are given.  Elapsed times can
be up to 24 hours long and are correct across midnight.


endtext
mar = 5                    ; establish report margin


showmenu
  "All":          "Run all 5 benchmark programs",
  "NoLoad":       "Do not run import tests; run all others",
  "Special":      "Run a special sequence of the tests",
  "Exit":         "Return to main program"
default "All"
to choice


; Invoke benchmarks
@row(),0
  style reverse
  ?? format("w80,ac", "Benchmark Timings for PARADOX on " +
                      strval(today()) +" at " + strval(time()) )
  style
@row()+1, mar
  ?? "Benchmark Name            Start              "
  ?? "Stop                Nr Secs"
@row()+1, mar
  ?? "------------------------  -----------------  "
  ?? "-----------------  -------"
```

```
switch

  case choice = "All":
    play "bench1"
    play "bench2"
    play "bench3"
    play "bench4"
    play "bench5"

  case choice = "NoLoad":
    play "bench2"
    play "bench3"
    play "bench4"
    play "bench5"

  case choice = "Special":
    r = row()  c = col()
    @0,0 ?? "Enter the sequence (e.g., 455):  "
    accept "a10" to sequence
    @r,c
    while len(sequence) > 0
      seq = substr(sequence, 1, 1)
      if len(sequence) = 1
        then sequence = ""
        else sequence = substr(sequence,2,len(sequence)-1)
      endif
      if seq <> " " and search(seq, "12345") <> 0
        then EXECUTE "play \"bench" + seq + "\""
      endif
    endwhile

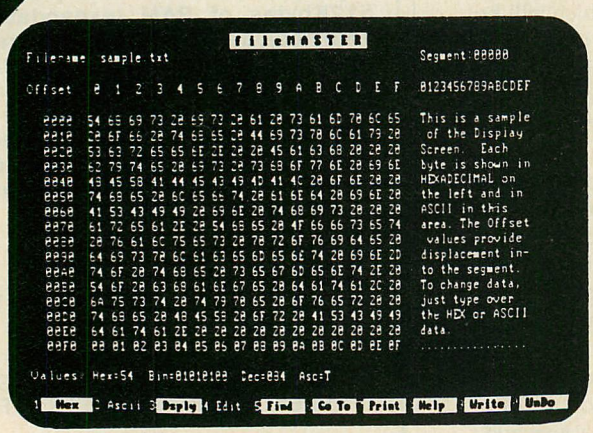
  case choice = "Exit":          return
  otherwise:                     return
endswitch


; Wait for results to be recorded on paper
@24,0
style reverse
?? format("w77,ar","Press Shift-PrtSc to print, other to exit")
style reverse, blink
?? "..."
style
x = getchar()   ;wait for a keypress
clearall
return


; end BENCHMKS.SC
```


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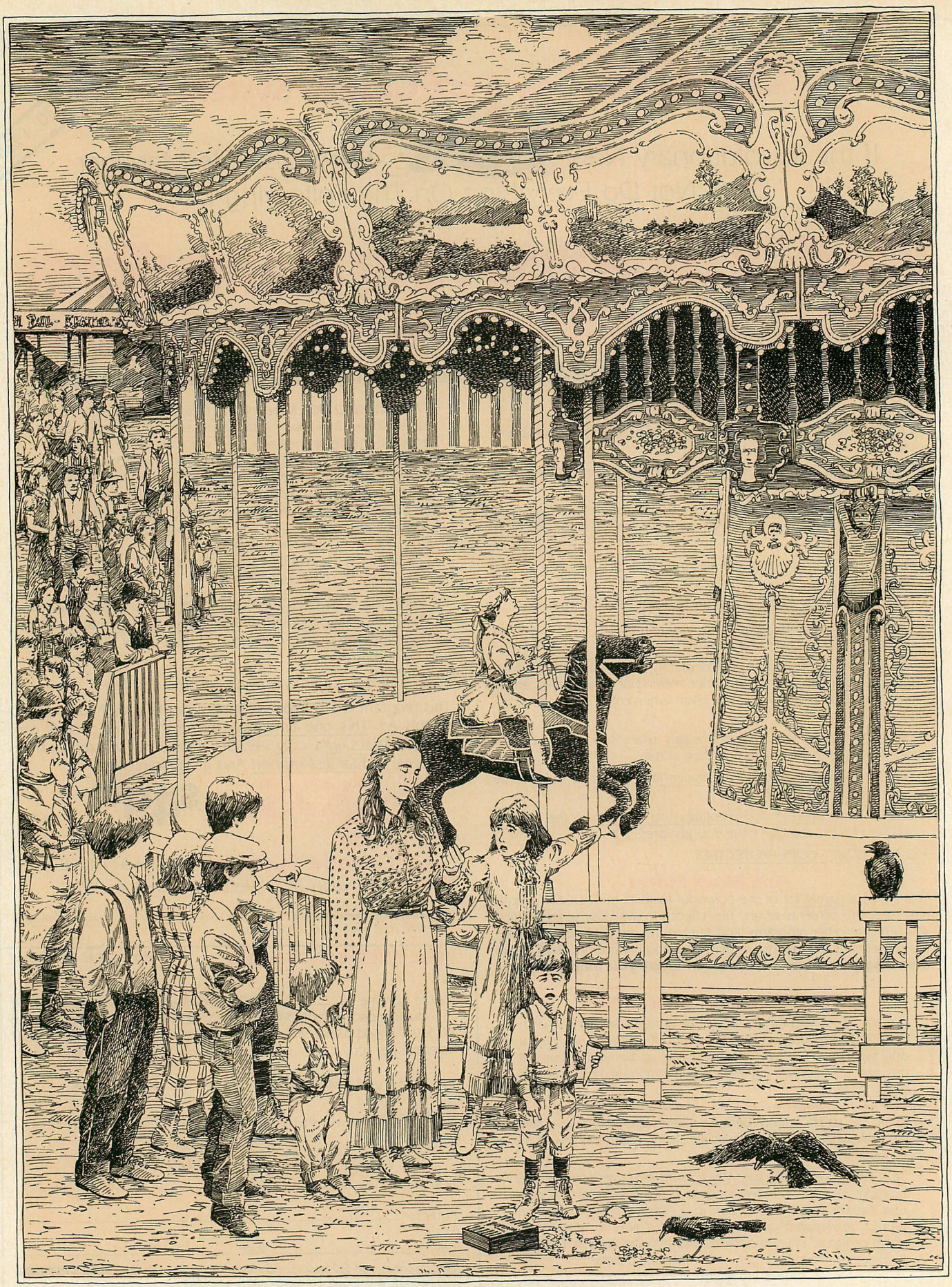
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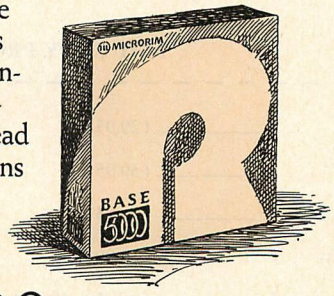
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atan	cpystr	fgets	putd	islower	peek	right$	strlen
atof	creat	fileno	getdate	isprint	perror	rindex	strncat
atoi	cursblk	filetrap	gettime	ispunct	poke	rmdir	strncmp
atol	curslin	find	geti	isspace	poscurs	scanf	strncpy
bdos	curscol	floor	puti	isupper	pow	setbuf	strsave
bdosx	cursrow	fopen	getkey	itoa	printf	setbufsiz	system
bios	cursoff	fprintf	getmode	keypress	putc	setcolor	tolower
biosx	curson	fputs	setmode	left$	putchar	setdate	toupper
calloc	delete	fread	gets	len	puts	settime	ungetc
ceil	drand	free	getw	log	putw	setjmp	ungetch
cfree	exec	freopen	heapsiz	log10	rand	setmem	unlink
chain	execl	fscanf	heaptrap	longjmp	read	sin	write
character	execv	fseek	hypot	lseek	readattr	sound	writechs
chdir	exit	ftell	index	malloc	reach	sprintf	xmembeg
chmod	exitmsg	fwrite	inp	alloc	writech	sqrt	xmemend
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close	fabs	getch	iofilter	mid$	writedot	sscanf	xmemput
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cmpstr	fdopen	getchar	isalpha	modf	rename	str$	_exit

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LEO J. SCANLON

An Alarm for the AT

The PC/AT can be set to signal the user with a beep, a message, or a picture of an alarm clock.

The PC/AT is equipped with an alarm that can be set to signal the user at any specified time. Unlike common alarm clocks, the one included with the AT can do more than simply ring—it also can be programmed to display a message or a picture of an alarm clock.

In short, setting the AT's alarm requires only that the programmer use a DOS interrupt to store the alarm time and a subroutine address in CMOS. When the time designated for the alarm to ring arrives, the subroutine is invoked. Users should note that this alarm subroutine must remain resident.

Documentation of the AT alarm is sparse. It is mentioned only in the *IBM Technical Reference Manual* for the AT (although it is not included in the index), as part of the description of the realtime CMOS clock. This section lists memory locations that are reserved to store second, minute, and hour values for the alarm. It also describes a status register bit that can be used to enable or disable the alarm interrupt. Although the alarm time and status bit are stored in CMOS, a power down also will disable the alarm.

More practical, useful information on using the alarm can be found in the listing for the AT's ROM BIOS in section 5 of the *Technical Reference Manual*. Included therein are descriptions of eight options for the 1AH time-of-day interrupt. In typical BIOS fashion, the options are selected by the contents of the AH register. The first four options read and set the time of the system clock and the realtime clock; the next two read and set the date; the last two set and reset (disable) the alarm. (For more information on reading and setting the clock, see "Setting the AT's Clock," Tech Notebook 28, Will Fastie, December 1984, p. 57.)

The AH=6 option enables the alarm and sets it to the hour, minute, and second values that are contained in registers CH, CL, and DH, respectively.

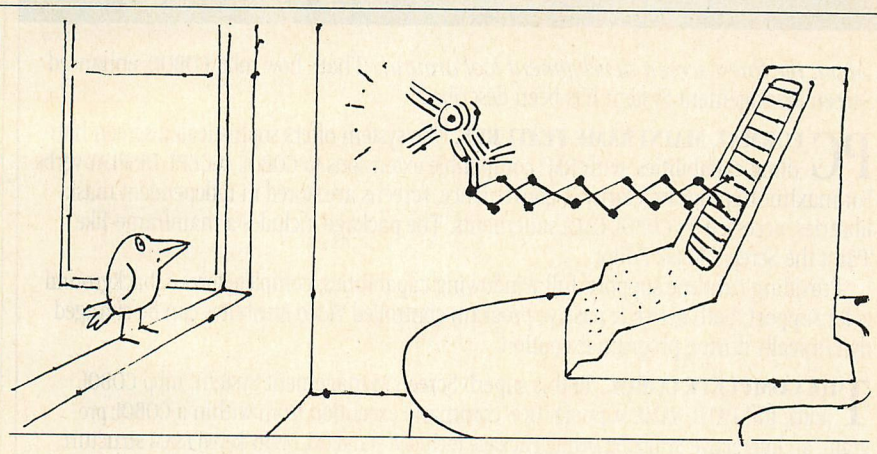


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Each time value is a binary-coded-decimal (BCD) number; the hour value conforms to the international time format and includes numbers between 00 and 23. For example, the following instructions set the alarm to ring at 1:35 p.m.:

```
MOV   CH,13H   ;Set hours to 1 p.m. (BCD
               ;format)
MOV   CL,35H   ;minutes to 35,
MOV   DH,0     ;and seconds to 0.
MOV   AH,6     ;Select the set-the-alarm
               ;option.
INT   1AH      ;Issue a time-of-day
               ;interrupt.
```

Disabling or resetting the alarm is accomplished by the user entering these two instructions:

```
MOV   AH,7  ;Select the reset-the-alarm
            ;option.
INT   1AH   ;Issue a time-of-day interrupt.
```

If, for example, the system is left running overnight, these instructions can be used to disable the alarm and keep it from ringing the next day. An alarm always must be disabled before its setting can be changed. A system reset disables the alarm, as does a power down.

CHECKING THE TIME

After the alarm has been set to some specified time, the realtime clock circuitry within the system continually compares that specified time to the time registered on the AT's built-in clock. When the values for the specified alarm time and the time on the built-in clock agree, the clock sends an interrupt request signal and an interrupt number to the 80286 microprocessor. The 80286 uses the interrupt number as an index to the interrupt table (which is a list of four-byte addresses.)

The alarm's interrupt number is 4AH; thus, the 80286 reads the address contained in vector 4AH of the interrupt table. (Because the vectors start at address 0 and are each four bytes long, vector 4AH occupies locations 128H through 12BH.) When the AT is first booted (and each time that it is rebooted) the alarm vector is set to point to a do-nothing routine within the system's BIOS. To alter this and program the alarm to perform some other, more useful task (for example, to display a message), an interrupt handler routine that performs the desired task must be created by the user and its address must be stored in vector 4AH.

Each time the system is booted, DOS stores interrupt handlers in memory that complement those contained in the BIOS. Among them is a super-handler that provides function call options for interrupt 21H, one of which, 25H, stores an address in an interrupt

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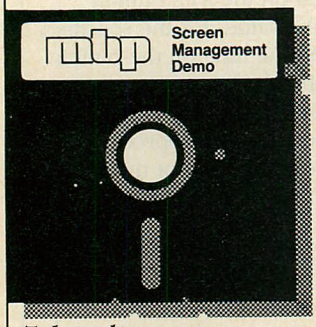
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vector. This is the function call needed to initialize vector 4AH.

To use the 25H function call, the user must load the vector number into AL and the handler's address into DS (segment number) and DX (offset). Thus, for example, to store the address of an interrupt handler called BEEPER in vector 4AH (assuming BEEPER's segment number already is stored in DS) the following sequence of commands must be executed:

```
MOV   AL,4AH      ;Specify vector 4AH
LEA   DX,BEEPER   ;Put the handler's offset
                  ;in DX
MOV   AH,25H      ;Select option 25H
INT   21H         ;Issue a DOS function
                  ;calls interrupt
```

Listing 1 is the source code for SETALARM.ASM, a program that sets the alarm to the time entered by the user. SETALARM performs the following:

- It resets (disables) the alarm.
- It checks to see if the alarm vector (4AH) already points to a resident copy of BEEPER. If not, the alarm vector is set to the BEEPER procedure within the SETALARM program. When it is time for the alarm to ring, this procedure is invoked and sends bell characters to the screen to beep the speaker five times or, if the user has created the necessary interrupt handler routine, to display a message.
- It prompts the user for the alarm time, including hour, minute, and second values, and calls a GET TIME procedure to read the keystrokes into a buffer called USER$ and convert them to BCD. GET TIME also performs some error checking; it calls a CHECK procedure to ensure that the keystrokes are digits between 0 and 9. In addition, the program makes sure that the user has entered a valid time value; it checks to see that the hour value is less than 24 and the minute and second values are less than 60.
- It sets the alarm using the AH=6 option of the 1AH interrupt. If BEEPER is not resident already, SETALARM leaves a copy of the procedure in memory.

To create the program called SETALARM.COM, assemble and link the SETALARM.ASM file (which is shown in the listing and also is available for downloading from PCTECHline), then convert this file to the .COM program using DOS EXE2BIN.

Leo J. Scanlon is the author of 15 microcomputer books. His most recent, Assembly Language Programming with the IBM PC/AT, *was published by Brady Communications Co.*

LISTING 1: SETALARM.ASM

```
;-------------------------------------------------------
; Set the PC/AT alarm to user-specified time.  Points alarm
; vector to BEEPER procedure which remains resident.
;-------------------------------------------------------
; (c) Copyright Leo J. Scanlon, 1986
.286c

PRINT$  MACRO  STRING           ; Macro that prints a string
        LEA    DX,STRING
        MOV    AH,9
        INT    21H              ;Function 9: display string
        ENDM

PROGRAM SEGMENT PARA PUBLIC 'CODE'
        ASSUME CS:PROGRAM,DS:PROGRAM,ES:PROGRAM,SS:PROGRAM
        ORG 100H                ;designed as .COM file

BEGINING:
        JMP MAIN                ;jump around procs and data

START_RESIDENT:

BEEPER   PROC
        PUSHA                   ;Save the user's registers
        MOV    CX,5             ;Beep five times
BEEP:   MOV    AL,7             ;Beep for one second
        MOV    AH,0EH
        INT    10H              ;Video EH: write char as TTY
        LOOP   BEEP
        POPA                    ;Restore the registers
        IRET
BEEPER   ENDP

END_RESIDENT:
RESIDENT_LENGTH EQU END_RESIDENT - START_RESIDENT
RESIDENT_OFFSET EQU START_RESIDENT - BEGINING + 100H

;-------------------------------------------------------------
; See if BEEPER proc is already resident.  Sets FIRST_TIME?=0 if
; alarm vector 4AH points to beeper routine, else leaves it 1
;-------------------------------------------------------------
FIRST_TIME?     DB 1
CHECK_BEEPER    PROC
                MOV AH, 35H
                MOV AL, 4AH
                INT 21H         ;function 35H (get interrupt vector)
                MOV DI,BX                       ; set up ES:DI
                MOV SI,[RESIDENT_OFFSET]        ; address BEEPER
                                                ; with DS:SI
                MOV CX,[RESIDENT_LENGTH]        ; set length for CMPS
                REPE CMPSB
                JZ ALREADY_THERE                ; ZF set means match
                RET
ALREADY_THERE:  MOV FIRST_TIME?,0
                RET
CHECK_BEEPER    ENDP

;-----------------------------------------------------
; data area: messages, prompts, and keystroke buffer.
;-----------------------------------------------------

CRLF     DB   13,10,'$'
BAD_DATA DB   'Digits must be between 0 and 9',13,10,'$'
BAD_HRS  DB   'Hours must be between 0 and 23',13,10,'$'
BAD_MINS DB   'Minutes must be between 0 and 59',13,10,'$'
BAD_SECS DB   'Seconds must be between 0 and 59',13,10,'$'

PROMPT   DB   'Set the alarm time.',13,10
         DB   'Enter values or press Enter for zero'
         DB   13,10,'$'
ASK_HRS DB    'Hour (0-23): $'
ASK_MINS DB   'Minute (0-59): $'
ASK_SECS DB   'Second (0-59): $'
USER$    DB   3,4 DUP(?)
              ; User's response in 5 byte buffer
              ; <length of buffer> <chars read> <char1> <char2> <ret>

;-------------------------------------------------------------
```


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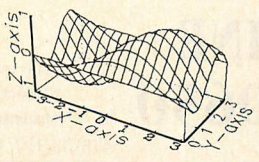
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CIRCLE NO. 187 ON READER SERVICE CARD

```
; GET_TIME reads up to two keys into string buffer USER$,
; then converts them into a packed BCD number in BL.
; If either key is invalid, it prints an error message and sets
; CF to 1.
;-------------------------------------------------------------

GET_TIME PROC
        LEA   DX,USER$      ;Read user's response
        MOV   AH,0AH
        INT   21H           ; function Ah (get keyboard input)
stop1:  PRINT$  CRLF        ;Advance to next line
        CMP   USER$+1,1     ;Check key count
        JAE   CONVERT
        SUB   BL,BL         ;User pressed Enter
        RET
CONVERT: MOV  AL,USER$+2    ;Get first key
        CALL  CHECK         ;Check this character
        JC    LEAVE         ;If it is valid,
        AND   AL,0FH        ; convert it to BCD
        MOV   BL,AL
        CMP   USER$+1,2     ;Is there another key?
        JB    CLR_CF
        SHL   BL,4          ;Yes. Put first digit in high bits
        MOV   AL,USER$+3    ;Get second key
        CALL  CHECK         ;Check this character
        JC    LEAVE         ;If it is valid,
        AND   AL,0FH        ; convert it to BCD
        OR    BL,AL
CLR_CF: CLC
LEAVE:  RET
GET_TIME ENDP

;-------------------------------------------------------
; CHECK makes sure an entry value is between 0 and
; 9.  If not, it displays an error message and sets CF to 1.
;-------------------------------------------------------


CHECK   PROC
        CMP   AL,'0'        ;If entry is < 0
        JB    ERROR
        CMP   AL,'9'        ; or > 9,
        JA    ERROR         ; print message
        CLC                 ;Otherwise, clear CF and return
        RET
ERROR:  PRINT$  BAD_DATA    ;Display error message
        STC                 ;Set CF and return
        RET
CHECK   ENDP

MAIN    PROC NEAR
        MOV   AH,7          ;Reset the alarm
        INT   1AH           ; AT BIOS interrupt 1Ah (reset alarm)
        CALL  CHECK_BEEPER
        CMP   FIRST_TIME?, 1
        JNE   USER_INPUT
        MOV   AL,4AH        ;Make the 4A vector point to BEEPER
        LEA   DX,BEEPER
        MOV   AH,25H
        INT   21H           ;function 25H (set interrupt vector)

USER_INPUT:
        PRINT$  PROMPT      ;Ask for alarm hour
HOUR:   PRINT$  ASK_HRS
        CALL  GET_TIME      ;Convert it to BCD
        JC    HOUR
        CMP   BL,23H        ;Make sure it's < 24
        JNA   HRS2CH
        PRINT$  BAD_HRS
        JMP   HOUR
HRS2CH: MOV   CH,BL         ; and put it in CH

MIN:    PRINT$  ASK_MINS    ;Ask for alarm minutes
        CALL  GET_TIME      ;Convert it to BCD
        JC    MIN
        CMP   BL,59H        ;Make sure it's < 60
        JNA   MIN2CL
        PRINT$  BAD_MINS
        JMP   MIN
MIN2CL: MOV   CL,BL         ; and put it in CL
SEC:    PRINT$  ASK_SECS    ;Ask for alarm seconds
        CALL  GET_TIME      ;Convert it to BCD
        JC    SEC
        CMP   BL,59H        ;Make sure it's < 60
        JNA   SEC2DH
        PRINT$  BAD_SECS
        JMP   SEC
SEC2DH: MOV   DH,BL         ; and put it in DH
        MOV   AH,6
        INT   1AH           ;AT BIOS interrupt 1AH (set alarm)
        CMP   FIRST_TIME?, 1
        JNE   CLEAR_OUT
        MOV   DX, RESIDENT_OFFSET + RESIDENT_LENGTH
                            ;first invocation - leave BEEPER resident
        INT   27H           ;interrupt 27H (terminate, stay resident)

CLEAR_OUT:
        RET                 ;BEEPER already in place so
                            ;exit normally
MAIN    ENDP
PROGRAM ENDS
        END BEGINING
```


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CIRCLE NO. 179 ON READER SERVICE CARD

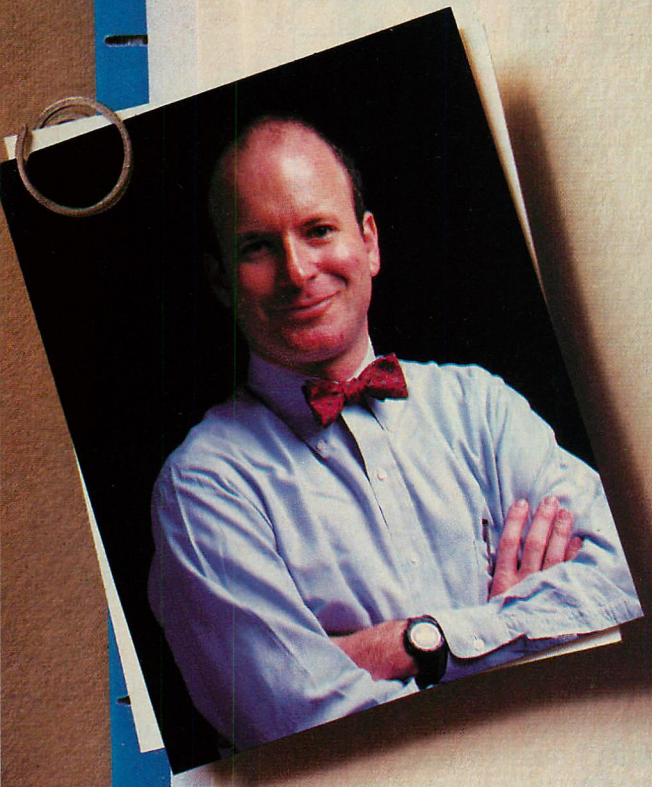
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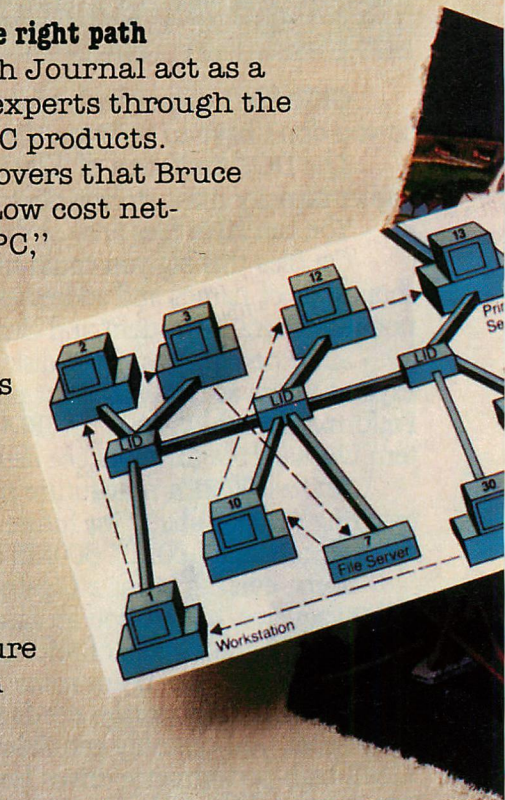
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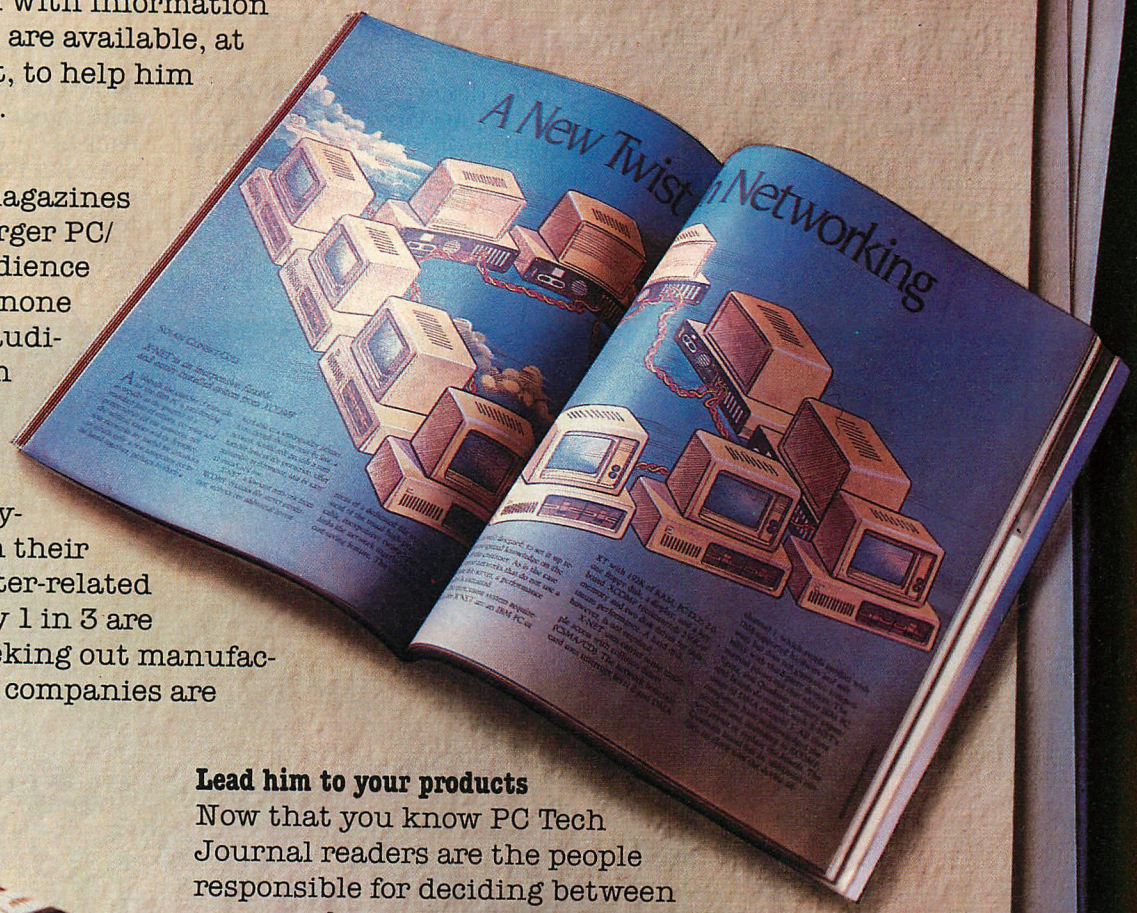
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I traded my 16K machine and all those disks for Lotus® 1-2-3 and 256K. And immediately got the urge to merge. I started by merging regional statements in Maine. But before I could get to Iowa, I ran out of gas.

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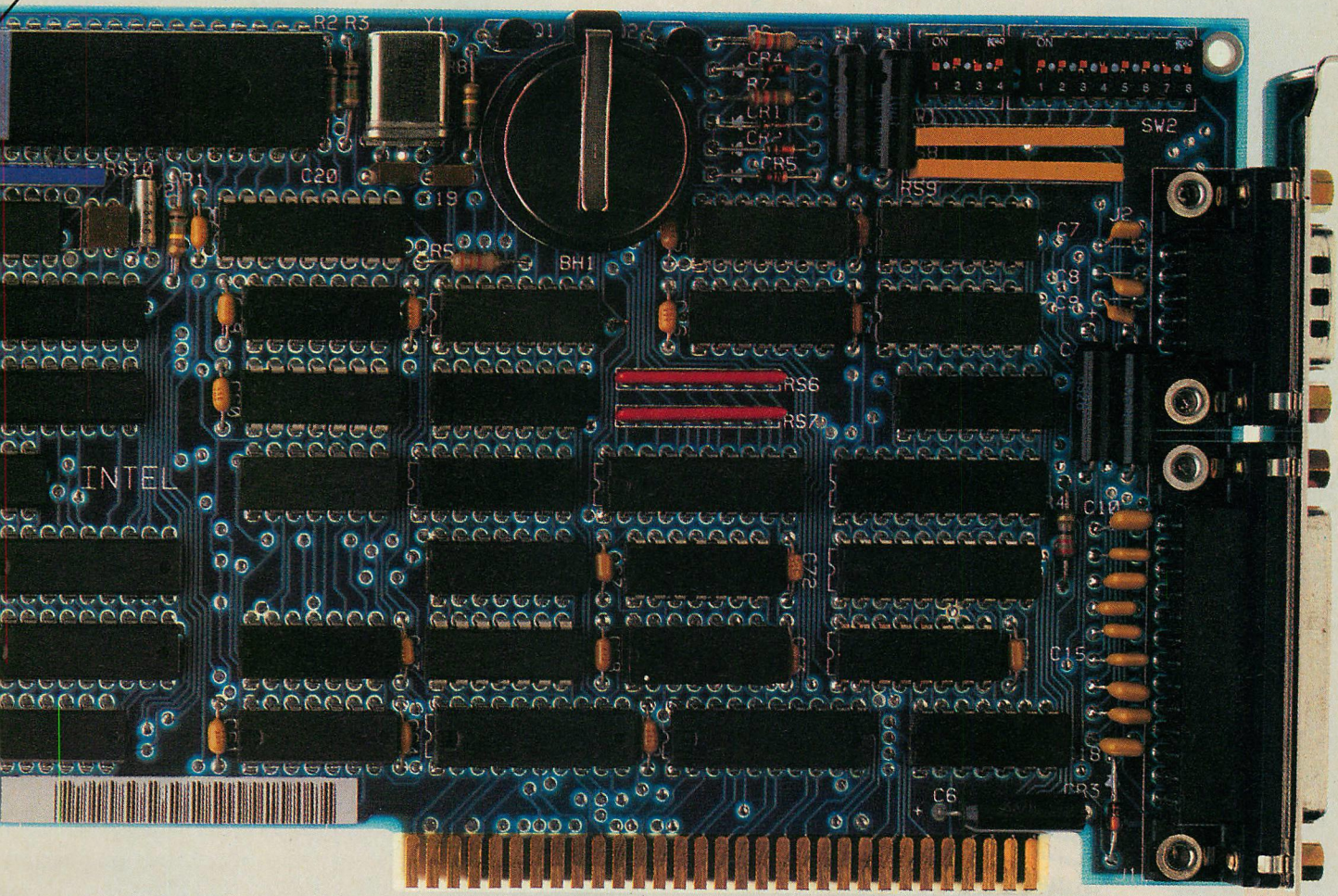
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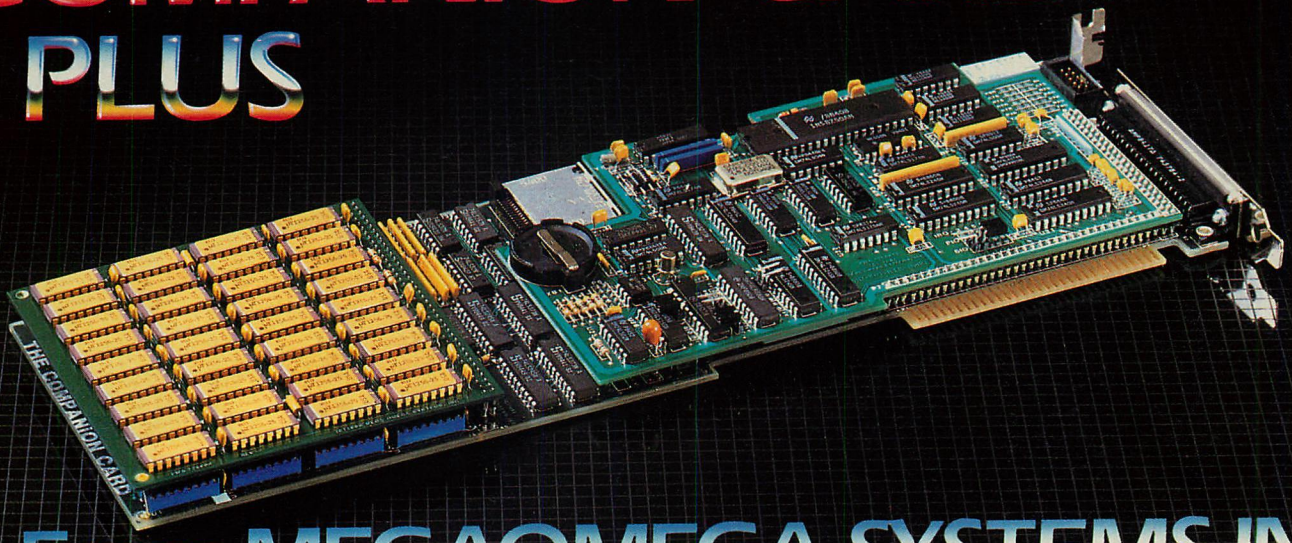
CIRCLE 216 ON READER SERVICE CARD



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CIRCLE 344 ON READER SERVICE CARD

The BLUELYNX Advanced COAX package contains an emulation board and software that functionally duplicate a 3278 terminal on a PC, thereby creating a multipurpose workstation. The package supports 25-, 32-, and 43-line screens via windowing, thus emulating 3278 models 2, 3, 4, and 5. It does not support 3279 color graphics.

Techland's emulator board incorporates 16KB of on-board memory for the screen buffer and scratch area. Its emulation software is outstanding. Besides the typical hot-key switches between DOS and 3270 sessions and the capture of screen image to printer and disk (not many packages do both), BLUELYNX captures and recalls screens to and from RAM. In addition, it allows user-defined screen templates to be used in conjunction with the screen captures to extract specific pieces of host data for use in PC applications or for output to a printer. The templated data screens can be captured to disk in DIF, COMMA (with commas inserted between fields for input to BASIC or Pascal programs), and WKS-ROW or WKS-COL formats (row- or column-oriented worksheet format for Lotus 1-2-3 or Symphony).

Additional BLUELYNX user-oriented features not found in many other emulation packages include macro definition and user profile. The software contains a macro set editor; the definitions can include arithmetic and logical operations and can be used for applications such as automatic logging onto a host or unattended file transfer. The profile editor enables a user with supervisor-level status to create and install user IDs for advanced functions. Access to such functions as the template editor, the macro set editor, and the file-transfer menu can be limited.

BLUELYNX's optional HFT file-transfer package is a fast, mainframe-based product that offers not only the standard TSO and CMS options, but also a sophisticated CICS program. In addition to uploading and downloading files, the CICS file transfer allows the user to display the name of any or all files within the user's VSAM area that match the file name or wild card specified. The program also lets the user delete any of these mainframe files. In TSO or CMS mode, the list operations and deletions can be accomplished with standard system commands. All three HFT modes offer uploading and downloading of both text and binary files. The user profile, which can be set up by a supervisor for security purposes, can restrict a user to downloading only as well as prevent access to the file transfer routines. In addition, TSO downloads offer built-in password protection.

The HFT mainframe component of the file-transfer package is distributed on 1,600-bpi magnetic tape. Techland Systems recommends that it be installed by mainframe system programmers. The PC side of the HFT installation is quite simple, however; the user only has to enter the file-transfer program name in a field on the environment menu screen that is used during the installation of the BLUELYNX package.

The package installs easily. The documentation includes an appendix for hardware switch settings for the board's 16KB memory address and I/O port. The appendix contains factory defaults and acceptable alternate settings. The software installation section describes batch file modifications if the switch settings are changed.

An optional feature of BLUELYNX is a 3270-PC look-alike keyboard. BLUELYNX allows redefinition of both the regular PC keyboard and the special 3270 keyboard via its keyboard map editor.

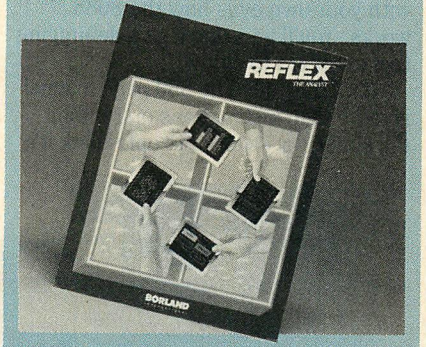
BLUELYNX is fast and complete, and more than equal to most tasks required of any 327X emulator.

—ROGER ADDELSON

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CIRCLE 345 ON READER SERVICE CARD

By now almost everyone knows the basic "business story" concerning Reflex. Built by Analytica Corporation as a database entry and introduced last year, it gained favorable reviews but nevertheless met with middling com-

mercial success; relatively few copies were sold at its price of $495. Then, this past summer, with the company apparently in deepening financial trouble, Philippe Kahn's Borland Corporation acquired Analytica and its flagship offering. On November 1, Borland reintroduced Reflex, slashing its price to a mere $95 (scheduled to rise to $145 on April 1) in the tradition of its other high-powered, low-priced products (Turbo Pascal, SideKick, the newly introduced Lightning). Borland claims to have shipped 10,000 copies of the system in the first week.

Reflex is a tightly built system and features a well-designed user interface. Its bargain basement price makes some of its features—especially its smooth file translation and report-writing facilities—very attractive as a supplement to these and other software products.

A graphics display is required to run Reflex. More specifically, the IBM monochrome adapter is *not* supported, although the Hercules Graphics Card is supported in graphics mode. Reflex uses a smaller, plainer font on the Hercules Card and thus puts more rows (but not more columns) on the screen. Users with EGA adapters and high-resolution monitors will be disappointed that Reflex writes to the screen only in the lower-resolution 640-by-200 mode and cannot use 640-by-350 mode.

Another important hardware issue for the Reflex user is memory, because the system keeps the entire database in RAM. A user with the minimum 384KB that is required to run Reflex is likely to encounter database size limits when using the system. At this time, the system does not take advantage of any expanded memory schemes, such as Intel's Above Board. One final hardware consideration for Reflex is its support of graphics printers and plotters. While it supports a few output devices, the list is not very long.

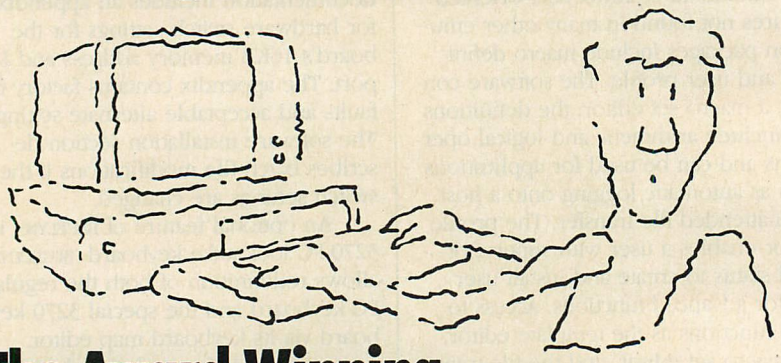
In terms of data modeling, Reflex can be seen as an extension of Lotus 1-2-3's database handling approach: a simple tabular (relational) view of data as fields (column names) and rows (record occurrences). But while this internal tabular architecture is fairly simple, Reflex provides five distinct *views* of user databases—different perspectives of looking at the same data. These views can be used as needs dictate.

List View. Rows in the relational table are presented in tabular style, with fields in a single line and as many rows displayed as the window will hold. The List View is spreadsheet-like in appearance, and resembles data stored under 1-2-3. This layout of data is also comparable to dBASE's Browse function or R:Base's Edit capability. In Reflex, however, the user has considerably more capacity to reorder, change, and otherwise affect the display of data in this format than would be possible in any of the other systems mentioned.

Form View. Rows in the relational table are presented one at a time on a screen format that can be painted by the user. The form is logical in the sense that it can be 500 columns wide and up to 500 lines deep; in these cases, the user pages around on the form to move from one location to another. Data fields on forms can be derived from other fields (expression of formulas is identical to 1-2-3 and Symphony) in the same row or be the result of one of Reflex's numerous functions.

Graph View. Five visual plots can be requested: scatter graph, line chart, bar chart, stacked bar, and pie chart. While exploded pie charts are not supported,

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the ability to display summaries, change scaling factors, and make a variety of other adjustments to the graphs means that the Graph View is a very useful dimension of Reflex. Of particular interest is the ability to see the specific database record (row) responsible for a given point on the graph.

Crosstab View. This is one of the most attractive parts of Reflex. The Crosstab display permits summaries of database records, displaying totals, averages, extremes with or without designated filtering criteria. This facility is available in two dimensions as well, enabling totals to be produced in a matrix arrangement, showing breakdowns by two different categories. All of this is carried out through easy-to-understand commands. Calculation of these crosstabs takes a couple of seconds if the number of records is in the hundreds, but when compared to similar facilities in 1-2-3 (such as data table operations), they appear to be at least as fast.

Report View. Reflex's report facility is not directly accessible from within the main Reflex program, but is a separate .EXE file that includes the system translate feature and other utilities. Reflex offers no Access-like facility to permit the user to move freely among all system components. Nevertheless, Reflex's report writer is a pleasure to use; controls are consistent with the rest of the product, the F10 key is always available to list the choices of fields, and selection criteria are easy to apply. While the data file can be sorted from within the Report View, the reporting process itself does not include a sort.

With the exception of the Report View, the user can quickly switch between all of Reflex's views and, in some cases (Form, Graph, and List), can have two views (actually, all three, although this is not especially practical) of data share the same screen.

Field types supported by Reflex include text, numeric, integer, and date (several useful date functions are included with Reflex). Also available is a type called *repeating text*, which is used to reduce memory resource requirements for textual fields with relatively narrow domains—that is, they have few occurrences across the database.

The command structure in Reflex is generally 1-2-3-like: the slash (/) key puts the user into command mode. Pop-down menus offer available choices, which can be typed in by first character. Some function keys are also the same as Lotus 1-2-3 (for example, F2 is the edit key as in the Lotus products, and edit mode itself is almost functionally identical).

Reflex actually improves on 1-2-3 in several respects. The most important of these is its F10 list function. It is useful in virtually all Reflex components, displaying (and allowing the user to choose) files in a directory, data names in a file description, and almost any choice within a command branch. (Symphony does the same with F10, although in Reflex the function seems more pervasively useful.)

In some cases, Reflex could have done a better job describing the current database settings and conditions. It does not seem to make general status information available when the user is in the middle of using various system pieces.

Reflex's File Translate program is a highly refined part of the system. Conversion of 1-2-3, Symphony (1.0, but not 1.1) dBASE II and III, pfs, and DIF files are directly supported, using a menu-based specification process that allows the profiles of specific conversion jobs



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to be saved for future use. In addition, support of ASCII files as input to conversion is provided, with restrictions. Reflex does not allow export of data to any of the above-mentioned systems.

Reflex is delivered with a single, perfect-bound user's guide of 400 pages. The manual is well-organized, contains plenty of clear examples, has a thorough reference section, and useful appendices. The detailed table of contents is more useful in tracking down a topic than the rather sparse index.

One shortcoming of Reflex is that it is *not* a database management system at all, but a file management system. Reflex supports no relationships between files (tables) and so is less than ideal for more complex applications: those that require data structuring.

The system has no programming language, which, given the constraint of no logical relationships, is not an acute disadvantage. Neither does Reflex support macros. Certainly being able to catalogue and subsequently call out common procedures (above and beyond Reflex's general facilities for saving crosstab views, report, and graph formats) would be helpful.

Reflex is a soundly designed system that does what it is intended to do very well. For its price, this is a functionally robust system, offering a wide range of powerful functions that are especially valuable in light of its powerful data import facilities. Reflex is without doubt a useful supplement to—although not a substitute for—existing spreadsheet and/or database packages.

—WILLIAM CASEY

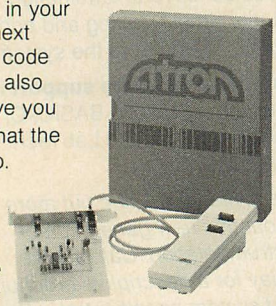
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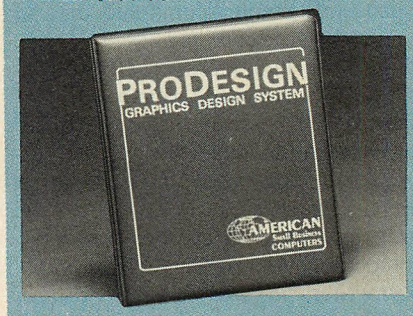
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American Small Business Computers has proffered a low-cost entry into the market for computer-aided design systems. ProDesign II is a two-dimensional drafting package that provides about 60 commands with several variations and special features.

ProDesign II operates by creating graphic primitives including, vectors, ovals, arcs, curves, painted areas, and text. Commands that depict vectors or curves can accommodate up to 200 points per command. Others use 1 to 6 points depending on the operation. The published program and database limits are sufficient to allow the system to produce drawings of moderate size.

The user creates each primitive by setting points and entering an appropriate keystroke command. Points may be set at finite locations or snapped to user-defined grid intersections. To set the environment, commands are provided to define the basic drawing unit, grids, cursor increment, line styles, line widths, and default text size and orientation. Specialty commands are included for drawing quarter-circles, half-circles,

arrows, and boxes and for auto-dimensioning between two points. The user can display distance and angle from a set point to the cursor location. After primitives are entered they can be moved, copied, rotated, deleted, scaled, saved, printed, and plotted.

The program can overlay the displayed database with others—without merging—for reference purposes. The system allows file merges so that databases of components may be merged into *assembly drawings*. Commands to zoom in and out are included. Panning is achieved in one of two ways. The ZOOM command can be used by setting a zoom factor of 1 and selecting the desired starting and finishing points. Alternatively, the user can move in large increments around the drawing. The whole drawing world is split into four sections; only one quadrant is visible on the monitor at one time. A function key is used to move between quadrants.

A special feature is the ability to scale graphics views into user-defined quadrangles. This permits rotations, simulated isometric views, and other variations with graphics and text.

ProDesign II has two text fonts that can be swapped in a database. Instructions on how to create fonts are included with the product. Text is displayed within an envelope that is determined by two to four defining points. If only one point is selected, the envelope reverts to default settings.

The user can output plots to printers and plotters. Output to disk files for later plotting or printing is not supported. Instructions on writing drivers for nonsupported printers and plotters are provided, although they seem terse.

One of ProDesign II's primary limitations is in environmental definition. The package requires the user to set up and remember the environment in advance of the drawing process—a cumbersome approach. If the design environment is always the same, environmental definition can be accomplished by setting up a special file before starting each new design. The environment must first establish the *basic drawing unit* by setting two points on the monitor screen and issuing the appropriate command. The grids must be carefully set up based on this visual unit. Only the cursor location and autodimensioning commands directly use the unit, so grid mismatch is possible. Trial-and-error plotting is necessary to get plots of undimensioned drawings using standard scales. The work-around is to put a scaled line on each plot.

The user-defined grids help, but the lack of continuous coordinate displays from user-defined datum lines is a serious limitation. The set-point-to-cursor location (vector length and angle), a command option, requires a lot of calculating for designs that hinge on single or multiple datum systems in order to enter many vectors. The lack of direct coordinate entry slows down the drawing process; this may be acceptable for small, noncomplex designs in which detail is minimal.

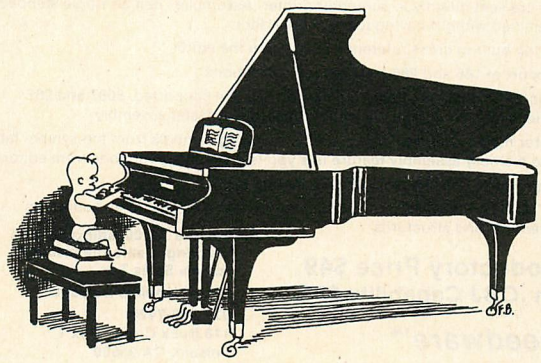
Another drawback of ProDesign II is its lack of a comprehensive set of editing commands to alter (move, delete, add) vectors or vertices, unpaint areas, etc. The editing tools provided are of the delete-and-redraw variety.

The system does not have a relational database or a macro command language. ProDesign II could evolve to support such attributes.

The documentation includes a user's manual, quick reference card, digitizer overlay, and program disks pack-

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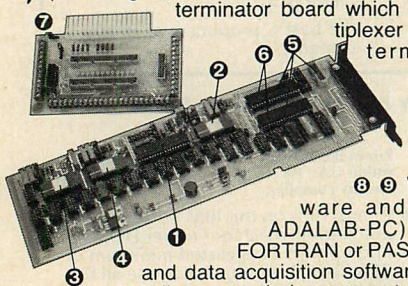
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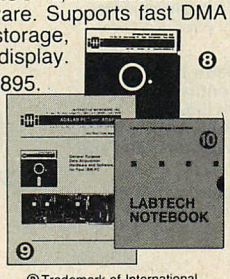
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aged in a plastic binder. The 99-page manual gets the user started, provides a partial command reference, includes information for setting up special peripheral drivers and fonts, and includes a sample pair of drawing lessons. However, it is often terse, lacks an error message reference section, has no index, and contains a few inaccuracies.

Speed is another area for concern for users of ProDesign II. It operates on ASCII databases, which take time to compile into graphics. This is especially noticeable during redraws.

ProDesign II styles itself as a computer-aided *design* system; it qualifies as an entry level computer-aided *drafting* tool. It produces scaled drawings, but the command set is limited for high-volume, heavy-duty, full-feature, production use. When viewed as a low-end, low-cost tool, ProDesign II lives up to expectations. While not a complete design tool, it can, with care, produce professional quality drawings.

—RICHARD ANGELL

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UPDATE

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Since its introduction in 1983, the Bernoulli Box has been a technologically exciting alternative to hard-disk storage for the PC. IOMEGA has applied Bernoulli's principle of fluid dynamics as a radically different approach to achieving flexible media stability.

The original Bernoulli Box (see "The Bernoulli Box," Giovanni Perrone, *PC Tech Journal*, June 1985, p. 144) is an external system slightly larger than the IBM PC system unit, containing one or two 10MB, eight-inch cartridge drives, a power supply, and a host adapter card that plugs into a PC expansion slot. The eight-inch removable cartridges use floppy disks for economical and highly reliable storage.

The new Bernoulli Box models use IOMEGA's half-height, eight-inch cartridge drives in a cabinet half the size of and 20 pounds less than the original product. The new models are available with one 10MB drive (A110H), two 10MB drives (A210H), one 20MB drive (A120H), or two 20MB (A220H) drives.

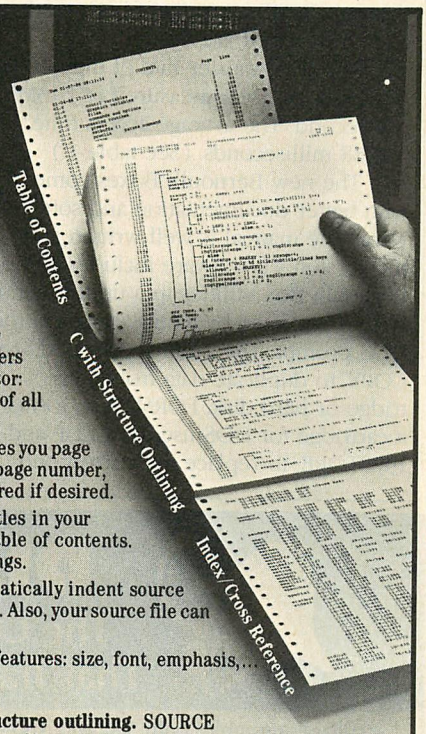
The new 20MB (actually 21.4MB) cartridge capacity comes from three sources: a redesigned read/write head with a narrower gap allowing a higher recording density per cartridge; special drive controller electronics to enhance IOMEGA's Run Length Limited (RLL) encoding scheme allowing denser data packing on the disk; and an effective doubling of media recording density in the new 20MB cartridges. The recording density in a 10MB cartridge is 258 tracks per inch (305 tracks in a

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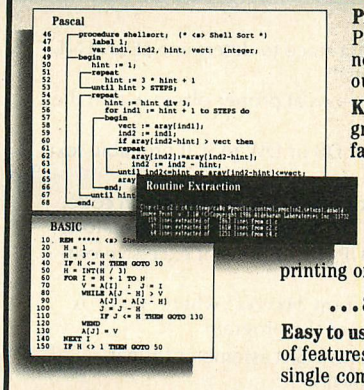
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30-mm recording band); whereas, the density in a 20MB cartridge is 554 tpi (654 tracks in the same 30-mm band). Because only one side of the media is used in the 10MB and 20MB cartridges, the potential exists for even more capacity (IOMEGA projects 50MB).

The new drives are *read-only compatible* with cartridges recorded on the 10MB drives (old or new). Data originally recorded on a 10MB cartridge can be read on a 20MB system, but data from a 20MB system cannot be recorded to a 10MB cartridge. When upgrading to 20MB, the user must transfer data to a 20MB cartridge if both read and write access are desired.

The data transfer rate of the new Bernoulli Box was measured at 1.13MB per second. The average access time was 38 milliseconds. (See table 1.)

The new Bernoulli Boxes come with better documentation and software. The manual is well written and the version 4.0 software includes all Bernoulli Box utilities in a useful menu system, accessed by typing IOMEGA at the DOS prompt. The utilities provided are: COPY, to duplicate data from a cartridge or hard disk; FORMAT, to format a cartridge for DOS use; IBACKUP and IRESTORE, to replace the corresponding DOS functions; INSTALL, to ease installation of the driver and utilities on a system disk; PARTITION, to create or delete the DOS partition or change the active partition on a cartridge; and TOOLS, to enable or disable the DiskSaver feature. DiskSaver helps prevent excessive wear on any one disk track by moving the head in a random pattern on the drive last accessed.

TABLE 1: *Bernoulli Box Benchmarks*

TEST (seconds per read)	**BERNOULLI** (AT IL=2)[a]
SEQUENTIAL READ	
1 sector	0.041
8 sectors	0.049
16 sectors	0.063
24 sectors	0.074
RANDOM READ	
1 sector	
0.10[b]	0.043
0.33	0.081
0.50	0.081
0.90	0.080
8 sectors	
0.10[b]	0.052
0.33	0.085
0.50	0.085
0.90	0.107

[a] *The interleave factor for the AT is 2.*
[b] *This is the seek distance—the distance the heads traveled as a fraction of the width of the disk platter.*

Doubling the memory capacity of the Bernoulli Box has produced benchmark results that are marginally slower than those for the old system. For a comparison, see table 3 in "The Bernoulli Box," Giovanni Perrone, June 1985, p. 152.

All utilities can be executed by typing a command at the DOS prompt. Good status displays, such as the name of each file being copied and the elapsed time to run FORMAT or COPY, are given where appropriate. The time required to format a 20MB cartridge is 8 minutes 41 seconds. The time to copy 37 directories and 1,383 files is 19 minutes 11 seconds.

A new Host Adapter Board serves as either a nonbootable (PC2) or bootable (PC2B) Bernoulli Box interface. The PC2 is used in PC/XTs, PC/ATs, or compatible systems with a hard disk. The PC2B allows booting from the cartridge on systems without a hard disk. The PC2B is $90 extra with the Bernoulli Box. An upgrade kit ($100) consists of three chips (RAM, ROM, and Logic) and four jumpers allowing conversion from a PC2 to a PC2B by filling the empty sockets on the PC2.

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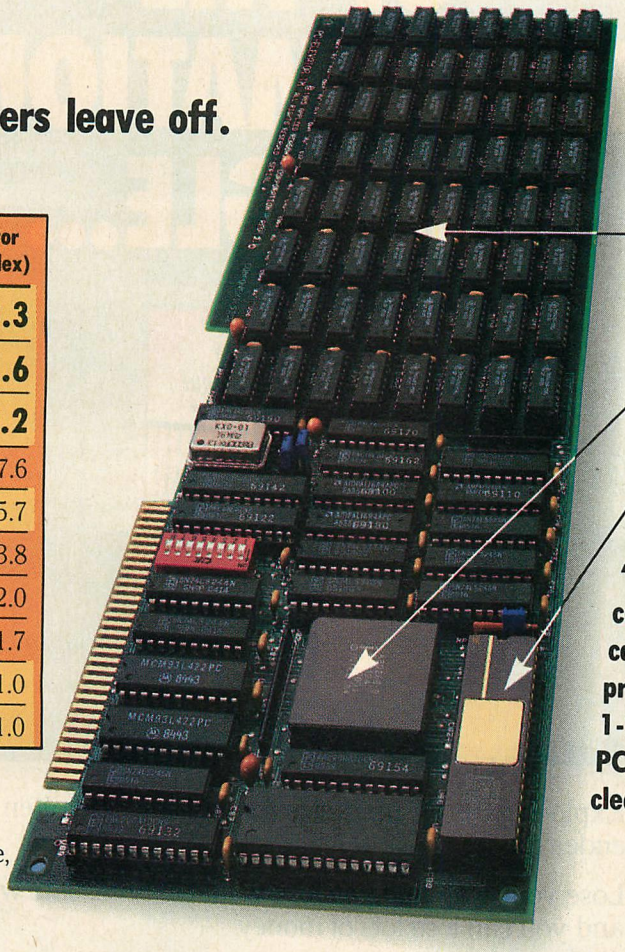
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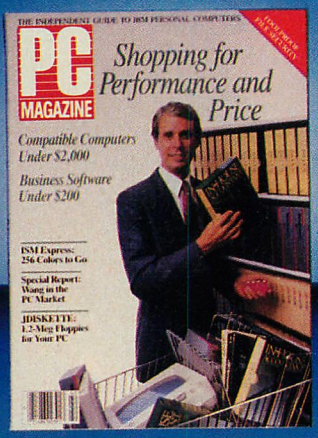
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Infringement by Compatibles

The courts are slow to decide the extent to which compatible computer programs can infringe on the original product.

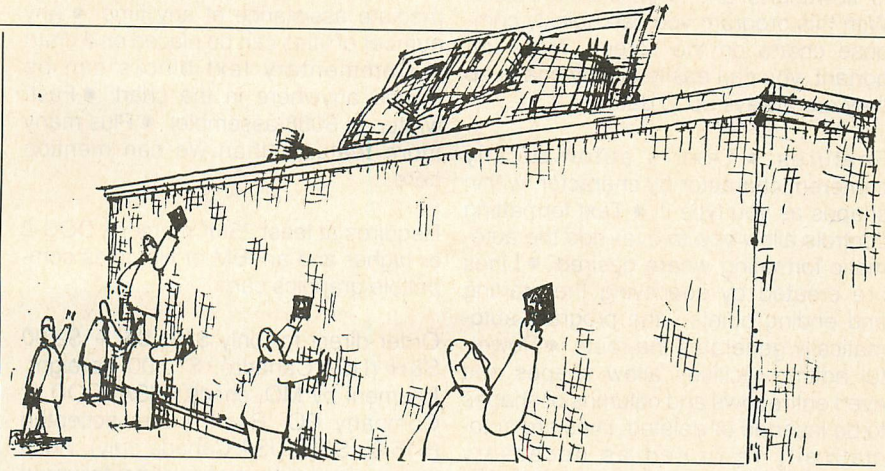


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In the first days of computer programming, programmers attempted to have their works patented. They claimed that, because their software reconfigured the internal electronics of a computer into a new machine, it should, if it met the requirements of patentability, be accorded the same protection as any product that improves upon an existing machine. The patent office must have realized the implications of this argument: because programming and the development of software are what make the computer such a valuable tool, requests for software patents would continue and the number of these requests would increase as the computer industry grew. The patent system, as it then existed, simply could not stand the strain.

The primary alternative method of protection available to programmers was the copyright. The copyright, however, was not applicable directly to computer programs. Traditionally, a copyright was intended to protect the expression of an idea, not the idea itself. Because the same task can be accomplished in many different ways in a computer program, a copyright may be inadequate protection. The author of VisiCalc, Dan Bricklin, made a fortune with his product; as he pointed out in a recent *Wall Street Journal* article (January 28, 1986), however, he could have made much more had the software been patented rather than copyrighted.

The introduction of ground-breaking software or hardware leaves behind it a trail of profitable opportunities for third parties who can develop peripheral products, second-generation programs, or cheaper versions of the original—for which research and development costs are reduced significantly once the concept has been provided. The Congressional Budget Office report on "Federal Financial Support for High Technology Industries" (see "Federal Encouragement," Legal Brief, January 1986, p. 189) appears to view as beneficial this process by which "technological followers...are able to retrace at low cost the thoughts of innovators and to learn from them;" the original developer probably would disagree.

The Apple v. Franklin case, in which Apple Computer compelled Franklin Computer to cease using an operating system that was allegedly infringing Apple's DOS, left undecided Franklin's defense that it was not an infringement to appropriate portions of code that were the "only and essential" means of accomplishing a given task (see "Memories Are Made of This," Legal Brief, June 1984, p. 34.) Thus, the critical question for the third-party developer of compatible devices or software becomes, "How compatible can the product be before it infringes upon the rights of the original?"

The NEC v. Intel case involving possible infringement of Intel's 8086/88 code by NEC's V20/30 chips (see "The Compatibility Risk," Legal Brief, April 1985, p. 179) is pending and may, at some time, produce a decision that will provide guidance on how to reduce the risk of infringement. Legal analysts would feel most confident, of course, if a decision were made by the Supreme Court. This, however, is not likely to happen in the near future. Even if the NEC case does reach the Supreme Court's docket, the Court appears to prefer those cases in which the issues are well defined.

A publishing case recently has been decided, however, that, although it provoked three dissents, helps to shed some light on the issue of compatibility as copyright infringement. Harper & Row, Publishers, Inc. v. Nation Enterprises (105 S. Ct. 2218, decided May 20, 1985) involved questions concerning the publication of selections from former-President Gerald Ford's memoirs. Harper & Row had bought the publication rights and, in turn, had sold to *Time* magazine the right to publish prepublication excerpts. *The Nation* magazine obtained from "an unauthorized source" a copy of the book manuscript and published its own prepublication excerpts shortly before *Time* was scheduled to do so. *Time* canceled its scheduled publication, and Harper & Row sued *The Nation*. The sole issue before the Supreme Court was whether *The Nation's* extracts from the Ford manuscript violated copyright. The majority opinion held that it did.

At the lower court levels, *The Nation* defended its actions with the arguments that it was protected by the "fair use" doctrine (Section 107 of the Copyright Act permits certain "fair uses"

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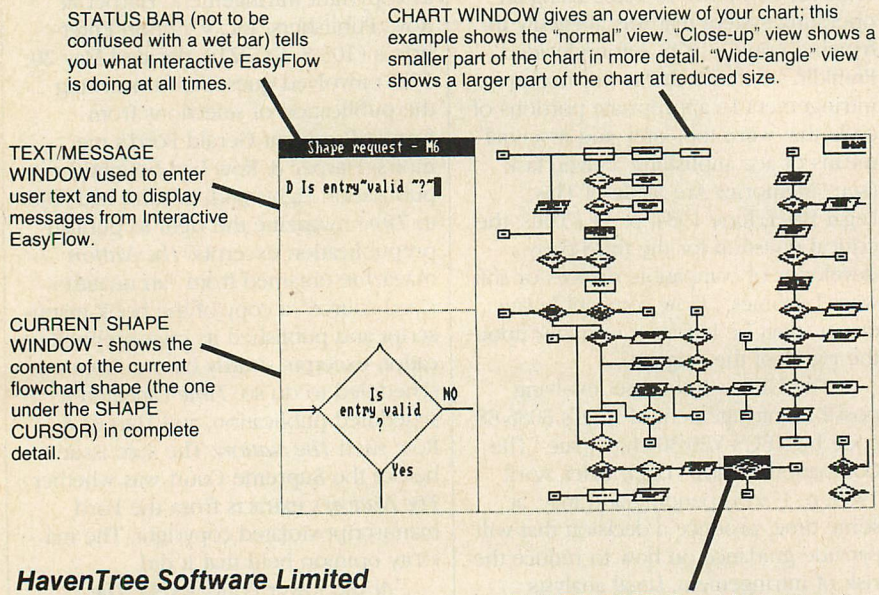
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of copyrighted works. These uses are to be determined by such factors as the purpose and character of the intended use, including whether it is commercial, the nature of the copyrighted work itself, the substantiality of the copying, and the effect of the use on the market for the copyrighted work). In addition, *The Nation* argued that the recitation of historical facts was not copyrightable. The trial court held that *The Nation's* use of the manuscript excerpts was not fair because it was for profit and because *The Nation* had used "the heart" of the work. The court also decided that, while the facts themselves were not copyrightable, Ford's selection and collection of those facts was. The court of appeals disagreed; wary of granting a monopoly on historical facts, it adopted a standard of verbatim copying for use in establishing infringement.

The decision by the court of appeals was seen as very beneficial in the eyes of the producers of computer compatibles, because it afforded them the argument that "fair use" should be measured in terms of the latitude of noninfringing expression of the same ideas. In historical works, similar expression of the facts is noninfringing because of the constraints placed on the expression by the requirement of historical accuracy. When applied to computer programming, this allowance translates to the understanding that the manufacturer of a compatible should be allowed to express in similar terms any copyrighted code that is necessary to making the new machine compatible with existing machines. To deny the right to this similarity of expression would be to grant a patent-like monopoly to the concepts.

The Supreme Court reversed the decision made by the court of appeals, noting that, "especially in the realm of factual narrative, the law is currently unsettled regarding the ways in which uncopyrightable elements combine with the author's original contributions to form protected expression." The Court, however, declined to settle the law.

The opinion passed down by the Supreme Court contains ammunition for both the compatible manufacturer and the manufacturer of the original.

The manufacturer of the original can point to the following language:

> This principle [that the copyright monopoly rewards the author in order to benefit the public] applies equally to works of fiction and nonfiction.
>
> The book at issue here...was two years in the making.

If he thus cites the most important parts of the work, with a view, not to criticise, but to supersede the use of the original work, and substitute the review for it, such a use will be deemed in law a piracy (citing a prior Supreme Court case concerning the use of George Washington's letters).

The Nation article is structured around...quoted excerpts which serve as its dramatic focal points.

The act focuses on "the effect of the use upon the potential market for or value of the copyrighted work." This...is undoubtedly the single most important element of fair use.

Compatible manufacturers, however, also can find helpful language in the following opinion:

No author may copyright his ideas or the facts he narrates.

The right of first publication implicates a threshold decision by the author whether and in what form to release his work. First publication is inherently different from other...rights in that only one person can be the first publisher....Because the potential damage to the author from judicially enforced sharing of the first publication right with unauthorized users...is substantial, the balance of equities...inevitably shifts. (This points out the Court's emphasis on the infringment of the right of first publication, created by the 1976 Copyright Act revisions.)

The Supreme Court has offered very little guidance to manufacturers and programmers struggling with the software copyright problem. It must squarely face the fact that computer software is not like other literature, then set up applicable guidelines.

The Court summed up the problem with the following quotation that is taken from a law review article (Gorman. "Fact or Fancy? The Implications for Copyright." 29 J. Copyright Soc. 560, 561 (1982)):

Even within the field of fact works, there are gradations as to the relative proportion of fact and fancy. One may move from sparsely embellished maps and directories to elegantly written biography. The extent to which one must permit expressive language to be copied, in order to assure dissemination of the underlying facts, will thus vary from case to case.

These are, indeed, words that would gladden any lawyer's heart.

Max Stul Oppenheimer, PC, is a partner in the law firm of Venable, Baetjer & Howard, located in Baltimore, Maryland.

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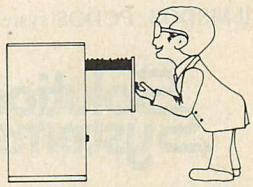
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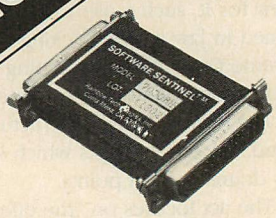


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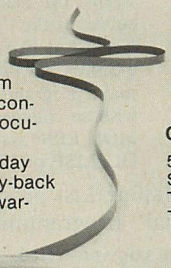
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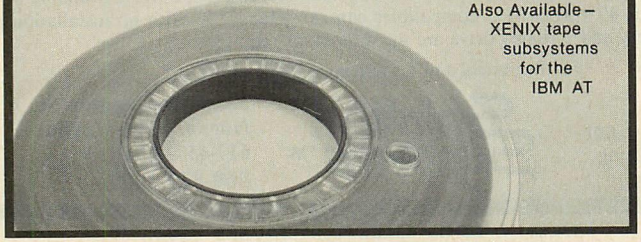
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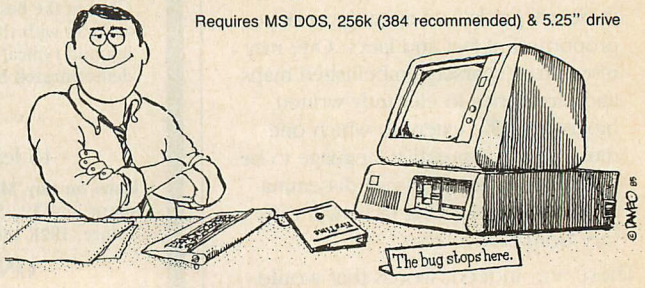
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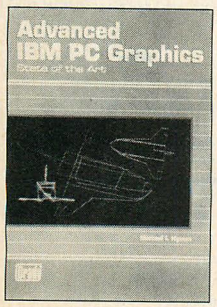
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Graphics Insight

From using BASIC to control a screen's color to state-of-the-art assembly language programming, this book deftly explains graphics on the PC.

Advanced IBM PC Graphics
Michael I. Hyman (Brady Communications Company, Inc., New York NY 1985) 341 pages, paper, $21.95



Advanced IBM PC Graphics is a computer graphics manual, textbook, and reference that addresses many needs. PC users just entering the world of computer graphics programming will find the book just what they need to point them in the right direction. Those who have been dabbling in computer graphics may supplement their knowledge with this book. Veteran graphics programers will think the book not only a useful reference, but also that it can teach them a new trick or two.

Author Michael I. Hyman begins with an introduction to the graphics screens of a PC, then moves into a discussion of ways to use BASIC to control a screen's color. A BASIC program is provided with this discussion to help indoctrinate the reader. Hyman continues this practice throughout the book—each topic covered in the text is accompanied by an executable program written in either BASIC or assembly language that provides a hands-on example. A diskette that contains the complete set of programs developed throughout the book is available separately at an additional cost of $20.

Chapter 2 introduces two-dimensional line graphics. The author takes pencil sketches or pictures and turns them into simple shapes that can be displayed on graphics screens as a series of points and lines. He manually transfers the sketches from graph paper to DATA statements in a BASIC program, which is a very crude method and one of the book's few faults.

The remainder of chapter 2 covers translation, aspect ratio, animation, and scaling using BASIC's LINE command. The programs included with this section are well constructed. Each new program is an expansion of the programs already presented. After these drawing techniques are developed with the LINE command, they are compared with similar techniques developed with the Graphics Definition Language.

Three-dimensional line graphics is Hyman's strong point. The book provides excellent information on three-dimensional translation, rotation, scaling, and perspective. It discusses the use of matrices, reflection, shearing, and clipping. The two-dimensional program developed in chapter 2 is expanded and modified to include these new features. Hyman discusses keyboard interaction as a way for programmers to change dynamically the parameters of three-dimensional rotation.

In chapter 4 the author switches from BASIC to assembly language programs to give users "speed and flexibility." The chapter introduces then expands upon assembly level graphics; each assembly language program essentially duplicates a BASIC program presented previously. No consideration is given to using the BASIC compiler to obtain the speed and power required to perform the graphics operations.

The author resumes his discussion of three-dimensional line graphics in relation to assembly language programming. He discusses techniques for producing multiple images that appear as one three-dimensional image when viewed from certain angles. Optic theory is combined with usable code to introduce the reader to a little used capability of PC graphics. Hyman's insights into three-dimensional drawing and display techniques is truly "state of the art." They are of value not only to PC users, but also to anyone interested generally in graphics.

Hyman discusses ways to program the Color Graphics Adapter directly. Complete information is provided on the registers and their respective uses. The chapter also presents a method that can be used to compact graphics screens to allow more screens to be saved on a single disk.

After concentrating on vector graphics in the first part of the book, Hyman turns to block graphics, beginning with the basics, then developing a simple bit-mapped graphics editor in BASIC. As he had done with vector graphics, Hyman begins his look at block graphics by transferring sketches on graph paper to DATA statements in BASIC. In this instance, however, the method may be justified, because it provides insight into the workings of PUT, a powerful BASIC command designed for use with block graphics.

Routines for scaling and rotating bit-mapped graphics are included, and various types of animation are demonstrated. The graphics editor uses BASIC commands, such as LINE, CIRCLE, PAINT, PUT, and GET, but produces a limited edit. Suggestions are provided for the reader to expand the program, but as long as it remains in the interpreter, it is too slow to be of use.

Hyman discusses using text modes for graphics as well as producing 16-color graphics with 80-by-25 resolution. In addition, assembly language routines are provided for doing block graphics and line graphics in text mode.

Advanced IBM PC Graphics covers a wide variety of graphics topics, many of which probably could be treated more completely in separate books. Overall, however, a great amount of insight into the world of IBM PC graphics is available in this book. The starting points for many graphics projects are combined with the basics of physics, mathematics, and programming.

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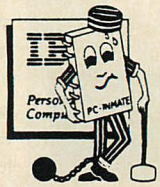
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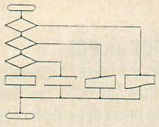
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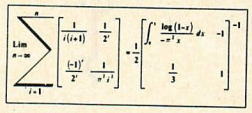
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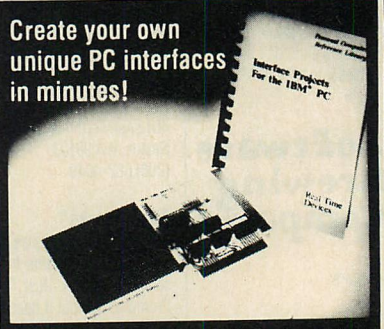
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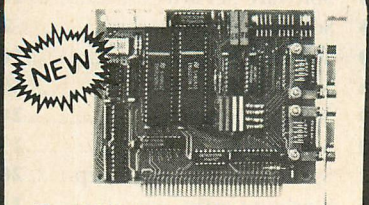
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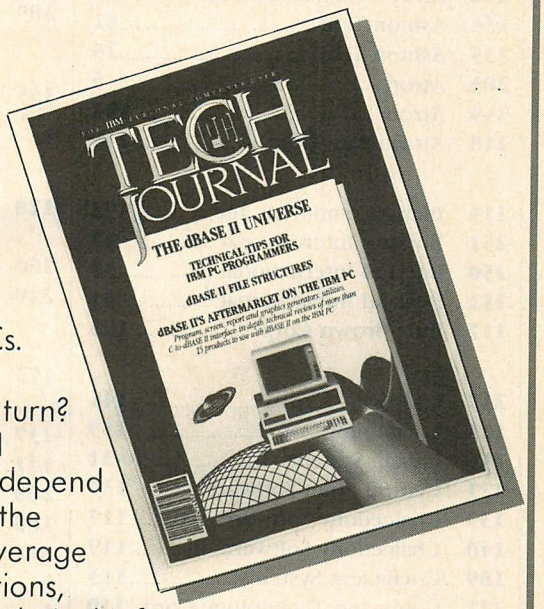
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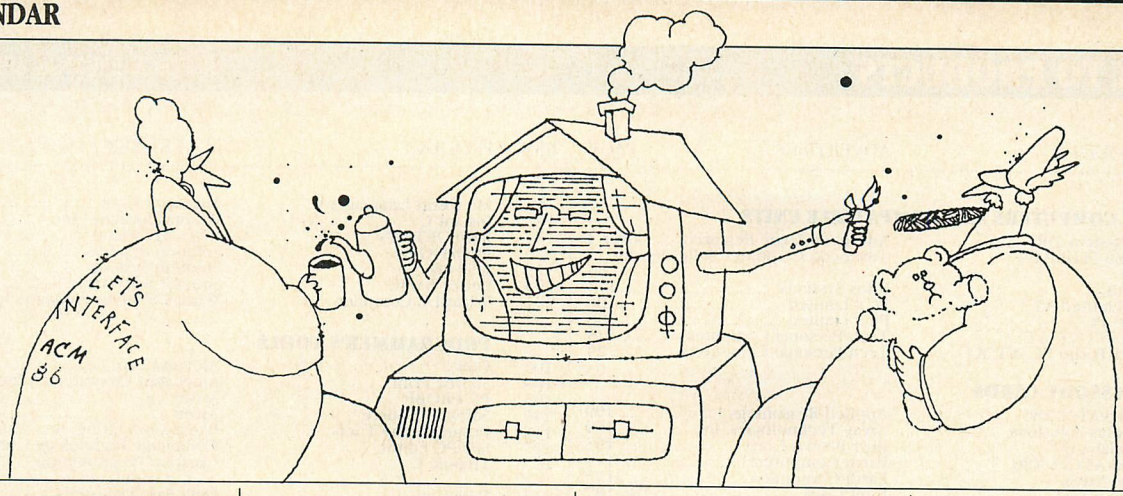


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Contact: Peter R. King, University of Manitoba, Department of Computer Science, Winnipeg, Manitoba R3T 2N2, Canada; 204/474-99-35

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Nice, France
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Spring COMDEX
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Contact: Linda Yogel, The Interface Group, Registration Department, 300 First Avenue, Needham, MA 02194; 617/449-6600

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Artificial Intelligence and Advanced Computer Technology Conference
Long Beach, CA
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MAY

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Vision Interface '86
Vancouver, British Columbia
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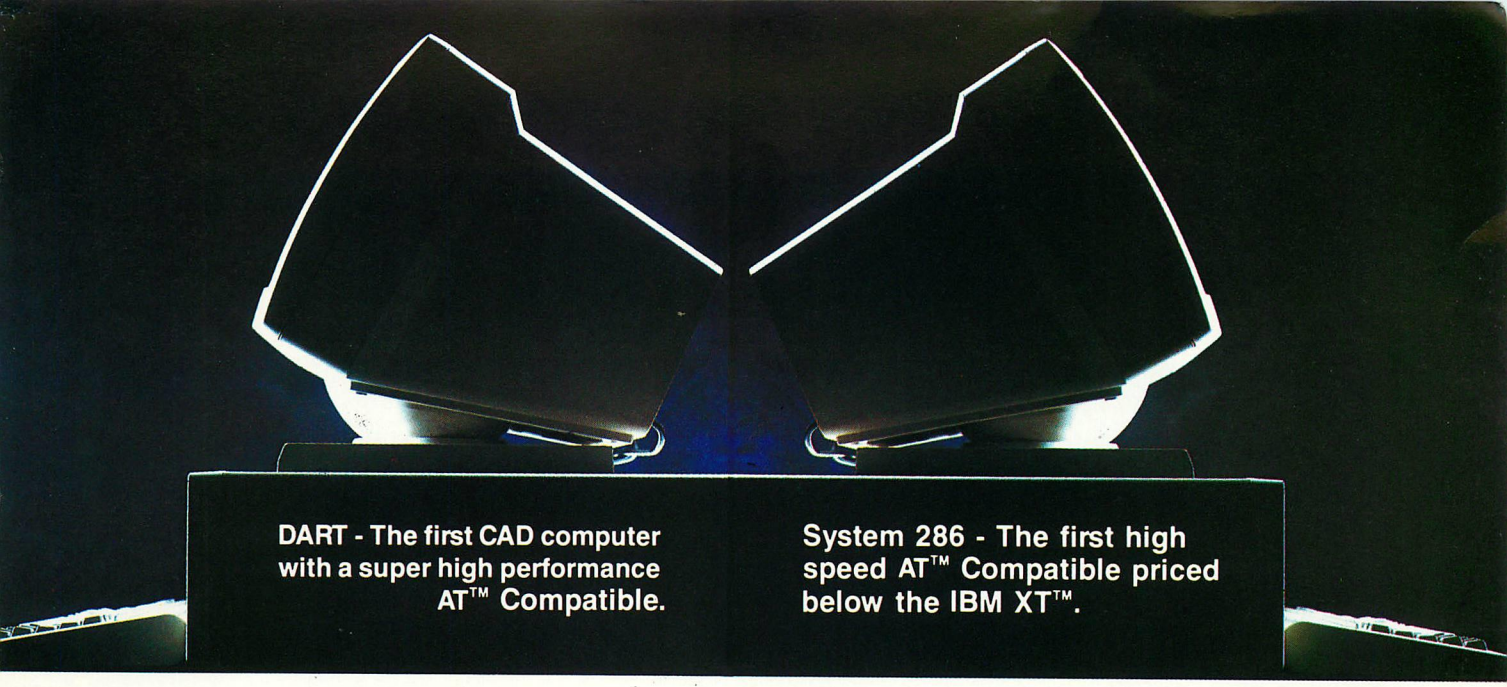
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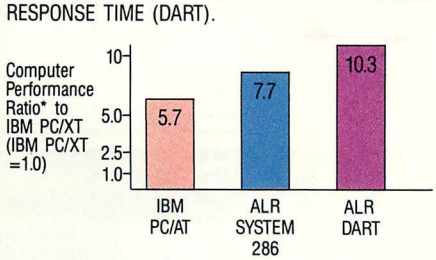


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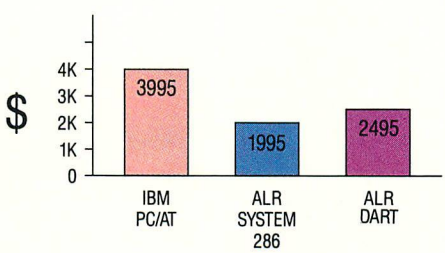
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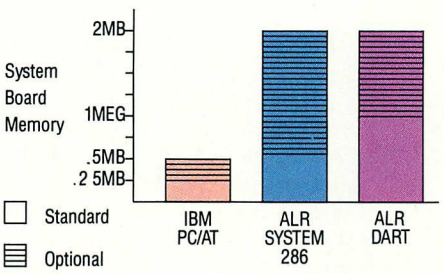


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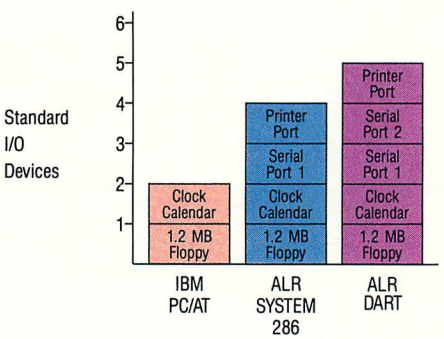
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